DOCUMENT RESUME

ED 341 572 SE 052 619

AUTHOR Smith, Kenneth L., Ed.
TITLE Communications. Technology Education-Mathematics and Science Interface Project.
INSTITUTION Maryland State Dept. of Education, Baltimore. Div. of Vocational-Technical Education.
PUB DATE 88
NOTE 139p.; For related documents, see SE 052 613-614, ED 234 019 and SE 052 616-620.
PUB TYPE Guides - Classroom Use - Teaching Guides (For Teacher) (052)

EDRS PRICE MF01/PC06 Plus Postage.
DESCRIPTORS Audio Equipment; *Communications; Creative Thinking; Industrial Arts; *Integrated Curriculum; Laboratory Experiments; Light; *Mathematics Education; Optics; Photographic Equipment; Problem Solving; Radar; Radio; Resource Materials; Science and Society; *Science Education; Secondary Education; Television; Transparencies; Visual Aids
IDENTIFIERS Maryland; *Technology Education

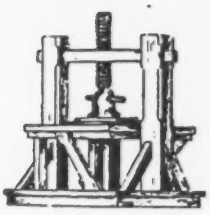
ABSTRACT

The curriculum materials contained in this document were developed through a cooperative effort by educators in the state of Maryland. It was a curriculum project aimed at the meaningful integration of mathematics and science. It is suggested that these materials be used in two significant ways. First, this document can serve as an instructional materials resource collection. An extensive variety of technology topics are covered, with each topic including detailed information sheets identifying the mathematical and scientific principles that could be studied in a technology education activity. Secondly, this document can serve as a materials resource guide. This is accomplished by providing a format and process for the creation of similar classroom instruction materials. Topics include: (1) Bell's liquid telephone; (2) camera; (3) crystal radio; (4) dynamic microphone; (5) early radio; (6) early television; (7) Edison's phonograph; (8) fiber optics; (9) holography; (10) lighthouse; (11) periscope; (12) phonograph; (13) photo enlarger; (14) pinhole camera; (15) printing press; (16) problem solving; (17) radar; (18) radio systems; (19) satellite systems; (20) speaker construction; (21) sundial; (22) telegraph; (23) telephone operation; (24) telescope; and (25) television camera. Each of the 25 technology topic entries includes the title, descriptions of the transparencies, science concepts, mathematical concepts, and transparency masters graphically illustrating the topic. A list of additional documents available from the Division of Vocational-Technical Education, Maryland Department of Education is provided. (KR)

**********
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
**********

ED341572

# TECHNOLOGY EDUCATION

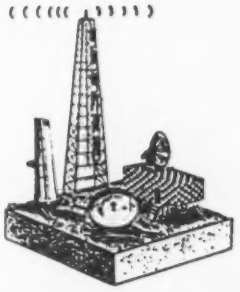


## MATHEMATICS AND SCIENCE INTERFACE CURRICULUM PROJECT

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Donald Maley

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."



U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

## COMMUNICATIONS

This publication was developed through federal funds from the Division of Vocational-Technical Education, Maryland State Department of Education.

The Maryland State Department of Education does not discriminate on the basis of race, color, sex, age, national origin, religion or handicapping condition in matters affecting employment or in providing access to programs.

SE053619



BEST COPY AVAILABLE

# TABLE OF CONTENTS

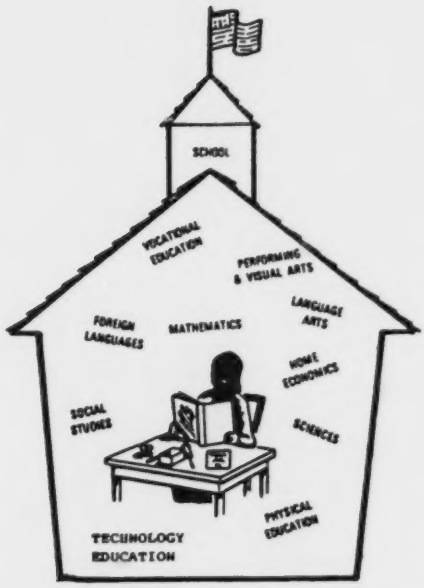

- CURRICULUM PROJECT STATEMENT
- STATEMENT OF PURPOSE
- WORKSHOP PROCESS
- ACKNOWLEDGEMENTS
- CONTENT INTEGRATION RATIONALE
- DEFINITION OF TECHNOLOGY EDUCATION
- TECHNOLOGY EDUCATION OPPORTUNITIES
- LONG RANGE OUTCOMES
- CLASSROOM USE
- DOCUMENT ORGANIZATION
- POINT OF VIEW
- CONTENT AREA DEFINITION
- TECHNOLOGY TOPICS
- ADDITIONAL DOCUMENTS (BY CONTENT AREA)

# MATH, SCIENCE, TECHNOLOGY EDUCATION INTERFACE

## A CURRICULUM PROJECT...

Aimed at enriching the content of industrial arts/technology education as well as demonstrating the potential for this area to make a significant contribution to the students' understanding of mathematics and science in the application of such disciplines in the technology education laboratory.

# THE PURPOSE...




There were four distinct purposes for understanding this project. Each of these have significant value; however, collectively they offer substantial rationale for pursuing holistic learning in our public schools.

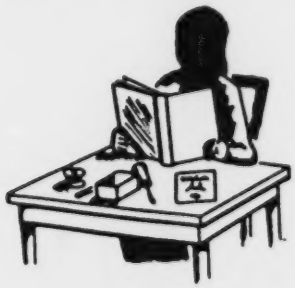
They are...

To assist understanding and cooperative relationships in our schools between content areas of mathematics, science and technology education.

To provide for the integration of mathematics and science into the teaching of technology education.

To develop curriculum materials for the integration of mathematics and science into technology education.

To provide inspiration and direction for further content integration for all subjects.



# THE PROCESS...

The math/science/technology education project was a cooperative effort by concerned educators in the state of Maryland. It was a curriculum project aimed at enriching the content of technology education through the meaningful integration of mathematics and science. This integration should demonstrate the potential for technology education to make a significant contribution to the students' understanding of these subjects through their application in the technology education laboratory.

The project was conducted over a three year period, beginning in the summer of 1985, continuing in 1986, and concluding in 1987. Each year, teachers from public schools throughout Maryland were assembled for two weeks. The organization was provided by the Department of Industrial, Technological and Occupational Education at the University of Maryland, College Park Campus. During these two week periods, teams of educators were involved in the process of creating technology education instructional materials that integrated the subject areas of mathematics and science. Appropriately, each team represented one school and included one teacher from each of the following areas: Industrial Arts/ Technology Education, Math and Science. It was the responsibility of the technology teacher to lead the team by providing direction for content development. As each technology teacher identified the content from his/her program, the science and math teachers would analyze the content for science and math applications. The outcome of this effort was the creation of appropriate visual masters that would communicate technological content as well as applied science and math principles. This master would be supplemented with information sheets carefully developed by the math/science members of the team. The information sheets would describe in greater detail the specific science and mathematics principles related to the technology content topic.

Follow-up activities involved workshops and in-service sessions in each of the local education agencies participating in the project. Finally, these curriculum materials were prepared for distribution to all participants, as well as local education agencies throughout the state.

# ACKNOWLEDGEMENTS...

This document is the result of a major cooperative effort over a three period at all educational levels.

| | |
|---|---|
| Project Director... | Dr. Donald Maley, Professor Emeritus Department of Industrial, Technological, and Occuaptional Education, University of Maryland, College Park Campus. |
| Technical Staff... | Anthony Gilberti, Larry Hatch, Charles McLaughlin, Larry Swartzlander, graduate students from the Department of Industrial, Technological, and Occupational Education, University of Maryland, College Park Campus. |
| Advisory Personnel... | Dr. Charles J. Beatty, Project Director, Technology Education, Maryland on the Move, University of Maryland. |
| | Dr. Gerald F. Day, Chief of Special Programs, Maryland State Department of Education, Division of Vocational-Technical Education. |
| | Mr. Allan B. Myers, Specialist of Industrial Arts/Technology Education, Maryland State Department of Education, Division of Vocational-Technical Education. |
| Edited By... | Kenneth L. Smith, Technology Education Teacher, John Hanson Middle School, Charles County Public Schools. |

# ACKNOWLEDGEMENTS

Teacher Teams...
(1985)

Arbutus Middle School

| | |
|---|---|
| Technology Teacher | Steve Bartley |
| Science Teacher | Linda McCelland |
| Math Teacher | James Hastings |

Calvert High School

| | |
|---|---|
| Technology Teacher | Carl Fenwick |
| Science Teacher | Terrance Klazer |
| Math Teacher | Kevin Michael |

Catonsville High School

| | |
|---|---|
| Technology Teacher | Bill Gibbs |
| Science Teacher | Buddy Brietenbach |
| Math Teacher | Ken Berry |

Cherry Hill Middle School

| | |
|---|---|
| Technology Teacher | Wilson Thompson |
| Science Teacher | Gretchen Lawson |
| Math Teacher | Kermit Williams |

Franklin High School

| | |
|---|---|
| Technology Teacher | Howard Spears |
| Science Teacher | Stanislaus Ziolkowski |
| Math Teacher | Joseph Noto |

Gaithersburg High School

| | |
|---|---|
| Technology Teacher | Willie Hill |
| Science Teacher | Dr. Donald Poe |
| Math Teacher | Deno Diamonds |

Glen Burnie High School

| | |
|---|---|
| Technology Teacher | Art Chenowith |
| Science Teacher | John O'Dell |
| Math Teacher | Glenna Hilditch |

# ACKNOWLEDGEMENTS

Teacher Teams...
(1985)

John Hanson Middle School

| | |
|---|---|
| Technology Teacher | Kenneth L. Smith |
| Science Techer | Christine Smith |
| Math Teacher | Drew Jepsky |

North Carroll High School

| | |
|---|---|
| Technology Teacher | Stephen Shepler |
| Science Teacher | Dean Packer |
| Math Teacher | Babette Leister |

Sparrows Point Middle School

| | |
|---|---|
| Technology Teacher | Will Heilman |
| Science Teacher | Ruth Jensen |
| Math Teacher | Paul Leimbach |

# ACKNOWLEDGEMENTS

Teacher Teams...
(1986)

Einstein High School

| | |
|---|---|
| Technology Teacher | Robert Wotkowski |
| Science Teacher | Russell Wright |
| Math Teacher | Mary Carter |

John Hanson Middle School

| | |
|---|---|
| Technology Teacher | Kenneth L. Smith |
| Science Teacher | Christine Smith |
| Math Teacher | Drew Jepsky |

Oxon Hill High School

| | |
|---|---|
| Technology Teacher | Charles Algire |
| Science Teacher | Michael Mickolay |
| Math Teacher | Diana B. McCusker |

Prince George's County Schools

| | |
|---|---|
| Frank Grahn | George Miles |
| Robert Gray | Roland Moore |
| Connie Jones | Nelson Sharpe |

Roosevelt High School

| | |
|---|---|
| Technology Teacher | Joseph Irizarry |
| Science Teacher | Bobbie Smith |
| Math Teacher | Mike Reidy |

Springbrook High School

| | |
|---|---|
| Technology Teacher | David Kaplan |
| Science Teacher | Paul Kroeger |
| Math Teacher | Regina Skyles |

Wilde Lake High School

| | |
|---|---|
| Technology Teacher | Charles Venable |
| Science Teacher | Nicholas Zoulias |
| Math Teacher | Eric Ebersole |

Woodlawn Middle School

| | |
|---|---|
| Technology Teacher | Richard Harbach |
| Science Teacher | Cheryl Migliarini |
| Math Teacher | William Gluth |

# ACKNOWLEDGEMENTS

Teacher Teams...
(1987)

Chesapeake Middle School

| | |
|---|---|
| Technology Teacher | Thomas Eoannou |
| Science Teacher | Donald Stenimler |
| Math Teacher | Dione McManus |

Eastern Vocational-Technical School

| | |
|---|---|
| Vocational Teacher | Earl Crussé |
| Science Teacher | William Stacy |
| Math Teacher | Albert Smith |

Earle B. Wood Junior High School

| | |
|---|---|
| Technology Teacher | Mark Green |
| Science Teacher | Richard Knight |
| Math Teacher | Julia Pepeta |

Galena Middle School

| | |
|---|---|
| Technology Teacher | Charles Cooper |
| Science Teacher | Margaret F. Crow |
| Math Teacher | Kevin Smith |

Merganthaler Vocational-Technical School

| | |
|---|---|
| Vocational Teacher | Jack Jacobs |
| Science Teacher | Gail Brayton |
| Math Teacher | Dwight Evans |

North Caroline High School

| | |
|---|---|
| Technology Teacher | Len Harmon |
| Science Teacher | Patricia Clay |
| Math Teacher | Mike Miller |

North Carroll Middle School

| | |
|---|---|
| Technology Teacher | Robert Lenz |
| Science Teacher | Tim Hontz |
| Math Teacher | Linda Guillen |

# ACKNOWLEDGEMENTS

Teacher Teams...
(1987)

Owings Mill High School

| | |
|---|---|
| Technology Teacher | Roland Phelps |
| Science Teacher | Sherman Kopelson |
| Math Teacher | Sharon Oland |

Taney Middle School

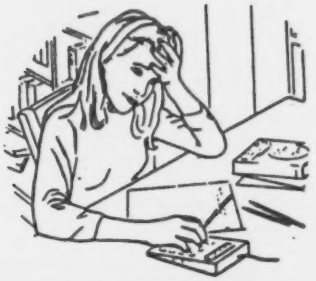
| | |
|---|---|
| Technology Teacher | Dennis Hearns |
| Science Teacher | Bruce Guinn |
| Math Teacher | John Davis |

West Frederick Middle School

| | |
|---|---|
| Technology Teacher | Paul E. Dunford |
| Science Teacher | Paula Lawton |
| Math Teacher | Rose Geiger |

# CONTENT INTEGRATION

## A RATIONALE...

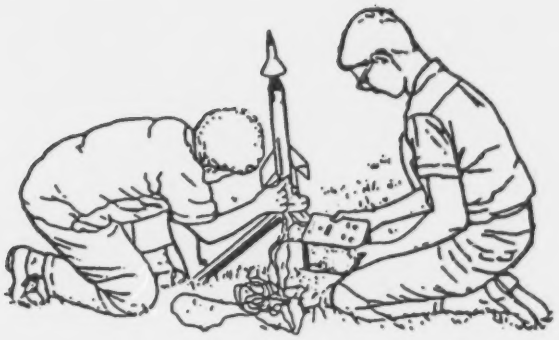


If technology education is to seriously provide for greater understanding and awareness of technological achievement, the issue of holistic learning must be addressed. If one is to truly understand any technological achievement, anthropological or contemporary, a discovery and realization of the specific scientific and mathematical concepts must be accomplished. To illustrate: a student studying rocket technology can use a few tools and machines to build a model of a rocket in any technology education laboratory. However, if that student is to gain a meaningful understanding of rocket propulsion, the scientific and mathematical relationships causing a rocket to function must become part of the instructional activity. Without this effort, the student is involved in a very superficial program.

It is most important to remember that the constructive activity is a vital part of the technology education experience. Generally, constructed items in class serve to motivate students. This motivation can be used to initiate further investigation into a particular curricular topic. Leading a student into a deeper understanding of a "cause and effect" relationship behind a technical device should be a carefully planned and managed instructional process. This process demands the inclusion of science and mathematics; that is, if understanding is the desired outcome.

Technology education offers, within its content and methodology, a prime vehicle through which the subjects of the school can be unified for relevant, meaningful learning on the part of the student. This is particulary true for mathematics and science. Technology education teachers permit students the opportunity to discover through investigation, research and problem solving the "how and why" relationships of science, math and technology education. This approach to subject integration would then continue and enhance the vital "experiential-active" quality that technology education has always valued.

# TECHNOLOGY EDUCATION



## A DEFINITION...

Technology education is an experienced-based curriculum area in which students study technology... its evolution, utilization and significance. It develops the technological literacy everyone needs. It involves learning experiences, including the application of mathematics and science, in such areas as communications, construction, manufacturing, power and energy, transportation, including the impact of these areas on the environment and society.

# TECHNOLOGY EDUCATION

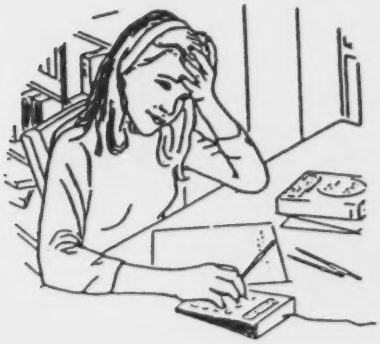
## OPPORTUNITIES TO...

Acquire knowledge, understandings and skills needed to function in a technological environment.

Integrate and apply concepts and skills of mathematics, science and communication.

Explore societal and environmental impacts of technology.

Solve problems through laboratory experiences which incorporate creative inquiry, ingenuity, discovery and interaction with technology.



BEST COPY AVAILABLE

# LONG-RANGE OUTCOME...

It is most desirable that this curriculum integration effort will provide direction for not only technology educators, but all concerned educational personnel pursuing meaningful, holistic learning in our public schools. However, as with any curriculum development experience, its usefulness depends on further creation and appropriate implementation by teachers in their classrooms. This body of work has already furnished sufficient guidance for some workshop participants to design and utilize additional materials suitable for use in their particular programs.

It has been convincingly argued that technology education can lead the way for meaningful, relevant subject integration in our schools. The effort in this curriculum project supports that argument. If teachers from the content areas of mathematics, science and technology education can cooperatively discuss, plan, design and produce curriculum materials such as those included in this document, certainly individual schools or local educational agencies should be able to coordinate similar activities. Technology educators should take this opportunity to provide the leadership necessary for further holistic curriculum exploration. Just as leadership and direction was provided by technology educators during this project, continued educational attempts to integrate mathematics and science into the technology education curriculum should be guided by individuals in technology education. The technology laboratories and curricula offer students that place within the school that can bring real understanding to all subjects.

The instructional materials contained in this document serve as examples of successful curriculum integration. The key to this success was carefully managed cooperation among concerned educators. Continued usefulness of these materials will certainly depend on carefully planned and supervised strategies. It is suggested that this document provide the impetus for workshops, seminars and various other in-service activities at all educational levels. The goal... appropriate and meaningful application of mathematics and scientific concepts into technology education.

# CLASSROOM USE...

One of the goals of this document is to provide for continued mathematics, science and technology integration. With this in mind, it is suggested that these materials can be used in two significant ways. However, it is important to realize that effective use of this document greatly depends on the initiative of technology teachers, resource teachers and supervisory personnel.

First, this document can serve as an instructional materials resource collection. The teams of educators who participated in the three year workshop have produced an extensive variety of technology topics presented as part of their individual programs. Each topic includes detailed information sheets identifying the mathematical and scientific principles that could be studied in the technology education activity. The quantity and depth of study for these math and science concepts remains at the discretion of the technology teacher. Variations in content usefulness will also depend on individual school or classroom conditions as well as the grade level of students.

Because of the wide range of technology topics presented, many teachers will be able to simply review and select items appropriate for immediate use in the classes. Some will be useful with only minor modifications to subject content. After basic planning and curriculum consideration, most technology teachers should be able to include some of these materials as part of their technology instuction.

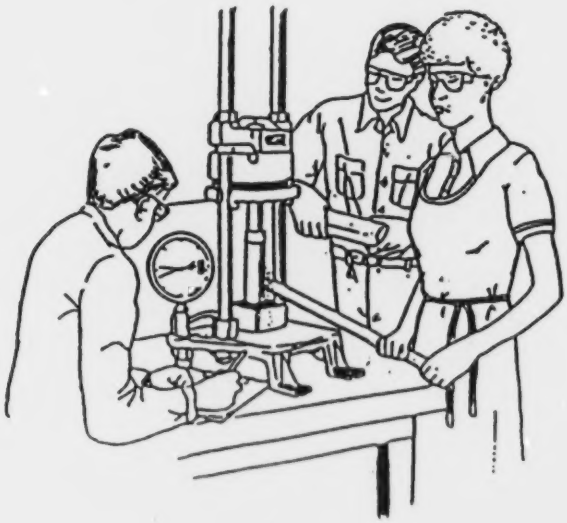
Secondly, this document can serve as a materials resource guide. This is accomplished by providing a format and process for the creation of similar classroom instructional materials. It is suggested that after reviewing these materials and understanding the cooperative 'teaming' process used in their creation, technology teachers will adopt a similar approach as they develop classroom materials appropriate to their programs. Although technology teachers generally possess backgrounds in mathematics and science, it is most valuable to pursue the assistance of the school's mathematics and science personnel in the identification of those principles peculiar to their programs. This effort will insure accurate and relevant subject integration with the technology education curriculum. In addition, math and science teachers could also reinforce technology education concepts in their curricula.

# ORGANIZATION...

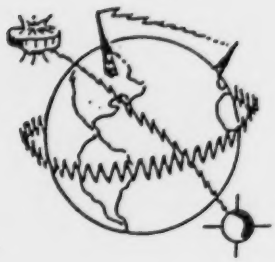
This document is organized into five categories. These categories are selected from the content areas identified in the definition of technology education.

Each technology topic has been placed in the most appropriate content area. However, some topics may be appropriate in more than one area.

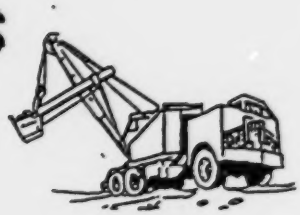
Each content category includes a statement of definition and a point of view.



## CONTENT AREAS:



- COMMUNICATIONS

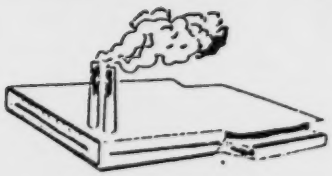


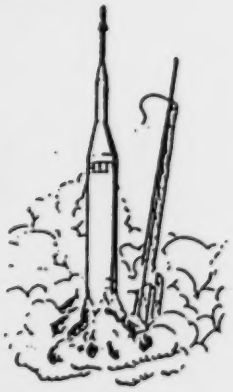
- CONSTRUCTION

- MANUFACTURING

- POWER AND ENERGY

- TRANSPORTATION





# COMMUNICATIONS

## Point of View...

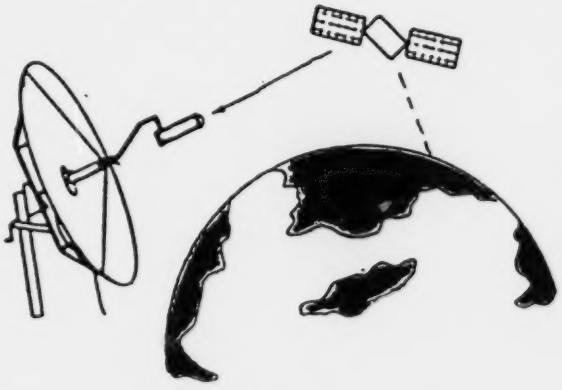
Everyone has experienced the frustration of not being understood when trying to communicate their ideas with others. Conversely, it it safe to say that all of us have misunderstood others in the communicative process. Amazingly, what seems such a simple accomplishment-the sharing of information between individuals can actually become confused and ineffective.

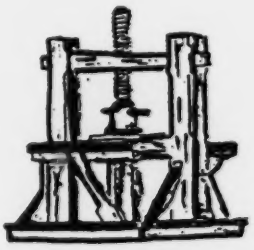
The need to communicate has always existed and will continue to be a primary need for people. Attempts to expand communicative methods and improve the quality of message processing has produced sophisticated and ingenious technologies. However, it is most important to realize this has been a very lengthy evolutionary process. This process has required the application of mathematical relationships and scientific principles in order to achieve the efficient communicative techniques we now enjoy. It is also most important to realize this evolutionary process is ongoing, that is, the electronic information age is here and growing. What is most dramatic is the fact that this change has been exponential. Communication technologies are becoming obsolete within a few short years after introduction as a new technology. Considering this accelerated rate of change, our future in communication technology should be very exciting and challenging.

Sending information quickly, in great quantities, and clearly, remains the communication challenge. Modern discoveries in research laboratories have produced materials and processes to transmit and receive information of all kinds over extraordinary distances. These achievements are a direct result of applied scientific knowledge and effective utilization of mathematical relationships. From the simple machine concepts used in the Gutenberg Printing Press to the very sophisticated electronics directing our satellite communications, the key to success has been the appropriate and effective use of our knowledge in the fields of science and mathematics. A continuation of this process must exist to meet the staggering communicative demands society will have in the near future. A failure to accomplish this will greatly diminish the nation's ability to compete worldwide.

# COMMUNICATIONS

AS A CONTENT AREA IS THE STUDY OF DEVICES, MATERIALS AND SYSTEMS THAT ASSIST INDIVIDUALS IN COMMUNICATING INFORMATION, IDEAS AND ATTITUDES. THIS INCLUDES TECHNOLOGIES THAT PROVIDE FOR... THE ACTUAL CREATION OF INFORMATION AND THE TRANSMISSION OF SIGNALS.





## INFORMATION BEING...

SIGNIFICANT DATA USUALLY COMPOSED OF WORDS, PICTURES OR BOTH. EXAMPLES INCLUDE... PRINTING, WRITING AND DRAWING DEVICES, TYPEWRITERS, WORD PROCESSORS, PRINTING PRESSES, CAMERAS, XEROGRAPHY, COMPUTERS. ALSO INCLUDED ARE EMERGING TECHNOLOGIES FOR DATA CREATION.

## SIGNAL TRANSMISSION BEING...

THE PROCESSING AND SENDING OF COMMUNICATION SIGNALS THROUGH VARIOUS MEDIUMS. EXAMPLES INCLUDE... RADIO, TELEVISION, TELEPHONE, ALSO... TECHNOLOGIES SUCH AS LASERS, MICROWAVES AND FIBER OPTICS AS WELL AS EMERGING TECHNOLOGIES FOR SIGNAL TRANSMISSION.

# COMMUNICATIONS
## TECHNOLOGY TOPICS

BELL'S LIQUID TELEPHONE

CAMERA

CRYSTAL RADIO

DYNAMIC MICROPHONE

EARLY RADIO

EARLY TELEVISION

EDISON'S PHONOGRAPH

FIBER OPTICS

HOLOGRAPHY

LIGHTHOUSE

PERISCOPE

PHONOGRAPH

PHOTO ENLARGER

PINHOLE CAMERA

PRINTING PRESS

PROBLEM SOLVING

RADAR

RADIO SYSTEMS

SATELLITE SYSTEMS

SPEAKER CONSTRUCTION

SUNDIAL

TELEGRAPH

TELEPHONE OPERATION

TELESCOPE

TELEVISION CAMERA

# ADDITIONAL DOCUMENTS

The following documents are also available from the Division of Vocational-Technical Education, Maryland State Department of Education.

## POWER & ENERGY

ANEMOMETER
AUTOMOTIVE AIR CONDITIONING
- ACCUMULATOR
- COMPRESSOR
- CONDENSER
- EVAPORATOR

BASIC ELECTRICAL CIRCUITS
BATTERY
BIMETAL DEVICES
CARBURETOR
CAPACITORS
CASTER
CATALYTIC CONVERTER
COMBUSTION CYCLE
COMPUTER COMMAND CONTROL
CONDUCTORS
COPPER WIRE RESISTANCE
DIESEL COMPRESSION RATIOS
DIODE
DRY CELL BATTERY
ELECTROMAGNETIC FIELD STRENGTH...
- CORE PERMEABILITY

ELECTROMAGNETIC RELAY
ELECTROMAGNETS
ELECTRON BEAM DEFLECTION
ELECTRONIC MAZE
FLYBALL GOVERNOR
FOUR STROKE ENGINE
FULL WAVE RECTIFICATION
GEARS
HALF WAVE RECTIFICATION
HYDRAULICS
IMPULSE STEAM TURBINE
IMPULSE WATER TURBINE
INCANDESCENT LAMP
LASER
LIFT PUMP
LIGHT EMITTING DIODES
LOGIC INVERTER
MAGNETIC COMPASS
MICROWAVE OVEN
MOVING COIL AMMETER
NEWCOMEN STEAM ENGINE
OHM'S LAW
OVERSHOT WATER WHEEL
PARABOLIC FURNACE
PARALLEL CIRCUITRY
PASSIVE SOLAR HEATING
RELATIONSHIP OF VOLTAGE TO BOYLE'S/CHARLES' LAWS
RESISTORS
ROCKET ENGINES
ROCKETRY
SERIES CIRCUITRY
SERIES-PARALLEL CIRCUITRY
SILICON PHOTOVOLTAIC CELL
SIMPLE MACHINES
SMOCK WINDMILL
SOLAR ENERGY
SOLAR HEATER
SOLAR WATER HEATER
TRANSFORMERS
TRANSISTOR OPERATION
TURBOCHARGING
TWO STROKE ENGINE
WIND TUNNEL
WIND TURBINE
WOOD BURNING STOVE

## MANUFACTURING

BANDSAW
BICYCLE FRAME BRAZING
BLIND POP RIVETING
BOARD FOOTAGE
BUFFING WHEEL
DESIGN AND CONSTRUCTION-FIBERGLASS BOAT
DIP MOLDING
DRILLPRESS
DRILLS
ELECTRIC SPOT WELDING
INJECTION MOLDING
JIGSAW
LASER DRILLING-WELDING
LATHE CUTTING SPEEDS
MICROMETER
OXYGEN-ACETYLENE TORCH
ROTATIONAL MOLDING
SOLDERING
THERMOFORMING
TIN SNIPS
WOOD FINISHES
WOOD LAMINATING
WOOD STAINS
WOOD TURNING
WOOD WAXES

## CONSTRUCTION

ABRASIVE TECHNOLOGY
ARCHITECTURAL MATERIALS UNDER COMPRESSION LOAD
BENDING WOOD
BRIDGE CONSTRUCTION
BRIDGE TRUSS
CHARPY IMPACT TESTING
CONCRETE STRENGTH
COPPER ELECTROPLATING
DECK CONSTRUCTION
DIMENSIONAL CHANGE IN WOOD
HANGER
HARDENING OF STEEL
HEAT TREATING METALS
HOUSE CONSTRUCTION
JOINING WITH SILVER SOLDER
MITER JOINTS
NAILING
ROOF FRAMING
SCREWDRIVER
STEEL
TRUSSES
WALL INSULATION

## TRANSPORTATION

BELL XP-59A AIRACOMET...FIRST AMERICAN JET
CANAL LOCK
CONESTOGA WAGON
GODDARD'S LIQUID FUEL ROCKET
HOT AIR BALLOON
MAGNETIC LEVITATION TRAIN (MAGLEV)
METRIC DRAGSTER
OPERATION SAIL
REACTION ENGINE CAR
WRIGHT BROTHERS AIRPLANE

TITLE: TELEPHONE

CATEGORY: INNOVATION

DESCRIPTION:

The first practical telephone was patented by A.G. Bell in 1876. In using this phone, the user shouted into the horn causing the flexible leather diaphragm to vibrate in accord with sound waves he produced. Fastened to the center of the diaphragm was an iron strip. When the diaphragm and iron moved closer to the magnet coil, the magnetic field of the coil increased because the air gap in the magnetic circuit was reduced. When the iron strip moved away from the core, the magnetic field decreased. Expansion and collapse of magnetic field, in accord with vibrations of the diaphragm, induced an alternating voltage in the coil. This voltage alternately added to and subtracted from the battery voltage, producing pulsations in the direct current leading to the other instrument.

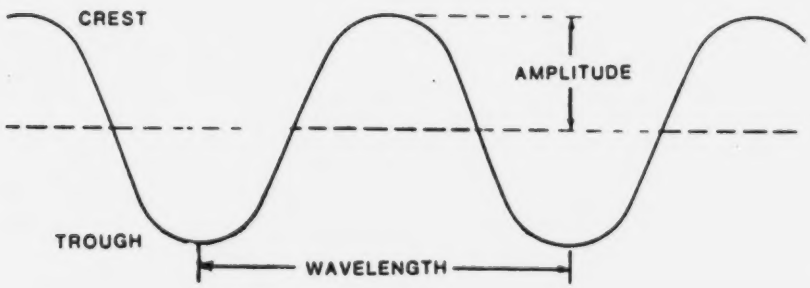
At the other instrument, the listener put his ear in the horn. The pulsating D.C. in his magnet coil produced a pulsating magnet pull on the pivoted steel strip fastened to the diaphragm, causing the diaphragm to vibrate in the same manner as the vibrations originally impressed on the first instrument.

SCIENCE CONCEPTS:

1. Energy is defined as the ability to do work.

2. Energy conversion occurs as energy is being transferred from sound to electrical to sound.

3. Sound waves are longitudinal waves.

4. 


   Crest is the high point of the wave.
   Trough is the low point of the wave.
   Wavelength is the distance from crest to crest or trough to trough.
   Amplitude is the height of the wave.

5. A magnetic field is said to exist in a region where magnetic forces can act.

6. Electromagnetic induction is the production of an electric current by a changing magnetic field.

TITLE: TELEPHONE

CATEGORY: INNOVATION

MATHEMATICAL CONCEPTS:

1. Simple Formulas

   Ohm's Law $I=E/R$

   $$\text{Current}=\frac{\text{Voltage}}{\text{Resistance}}$$

   $$\text{Frequency } (H_z)=\frac{\text{Speed m/sec}}{\text{Wavelength (m)}}$$

2. Ratio/Proportions

3. Use of rational numbers

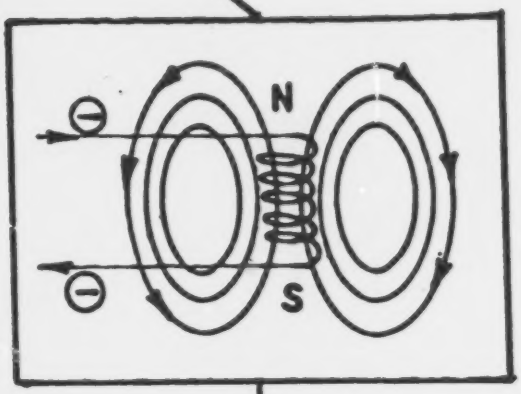
4. Solving equations

5. Mathematical operations/order of operations

# BELL'S TELEPHONE

ELECTROMAGNETIC INDUCTION:

$$V = N \times \frac{\text{CHANGE IN FLUX}}{\text{CHANGE IN TIME}}$$



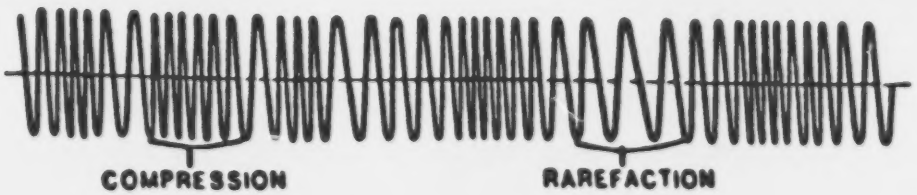

TRANSMITTER

RECEIVER

CONVERSION OF ENERGY

SOUND TO ELECTRICAL

ELECTRICAL TO SOUND




BEST COPY AVAILABLE

Title: The Camera

Category: Communications

Description: The camera has one main function, that is to record the image. Its working can be compared to the human eye. The eye has a lens which allows light to pass through and focus on the image. The image on the film is inverted or upside-down. In most cameras, the exposed film is removed from the camera and developed through a chemical process. A photographic print is then made from one of the most important means of communication and expression in our culture.

Both the human eye and the camera have some of the same functions — to control the amount of light passing through, to focus, and to record the image.

Math Concepts

1. Film speeds (ASA) - sensitivity to light.
2. F-number of lens = $\frac{\text{Focal length of a lens}}{\text{Diameter of aperature}}$

   Each successive f-number on a camera means that half the previous amount of light is now being allowed into the camera.
3. Use of ratios to determine the size of an image.
4. Measurement of chemicals in proper proportions for mixture when developing photographs.
5. Accurate timing in the development process.
6. Exposure = intensity x time.

Title: The Camera

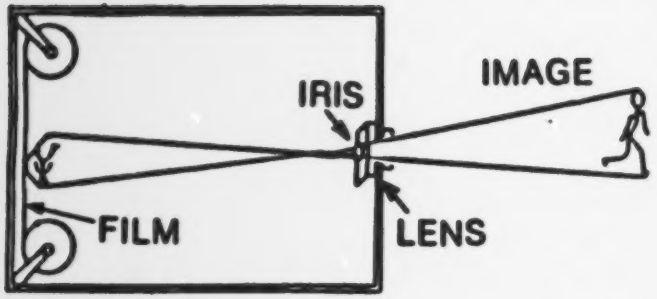
Category: Communication

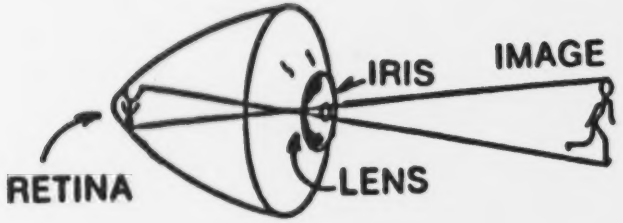
Science Concepts

1. Light is energy.
2. Energy can change in form.
3. When entering a denser medium, light is refracted (bent).
4. A convex lens converges light to a focal point.
5. A concave lens diverges light.
6. Light energy produces a latent image on a photographic emulsion.
7. Photographic film contains silver halides or silver bromides that are affected by exposure to light.
8. Silver halide is chemically reduced to metallic silver that is black or gray giving a negative image.
9. Photography, as well as vision, depends on reflected light.
10. The camera and eye have basic parts that perform like functions:

| Eye | Camera | Function |
|---|---|---|
| retina | film | captures image |
| lens | lens | focuses light |
| iris | iris (aperture) | adjusts light |
| eyelid | lens cap | protects |

# THE CAMERA




**CAMERA**

**EYE**

## SCIENCE CONCEPTS

EYE / CAMERA SIMILARITIES

LENSES

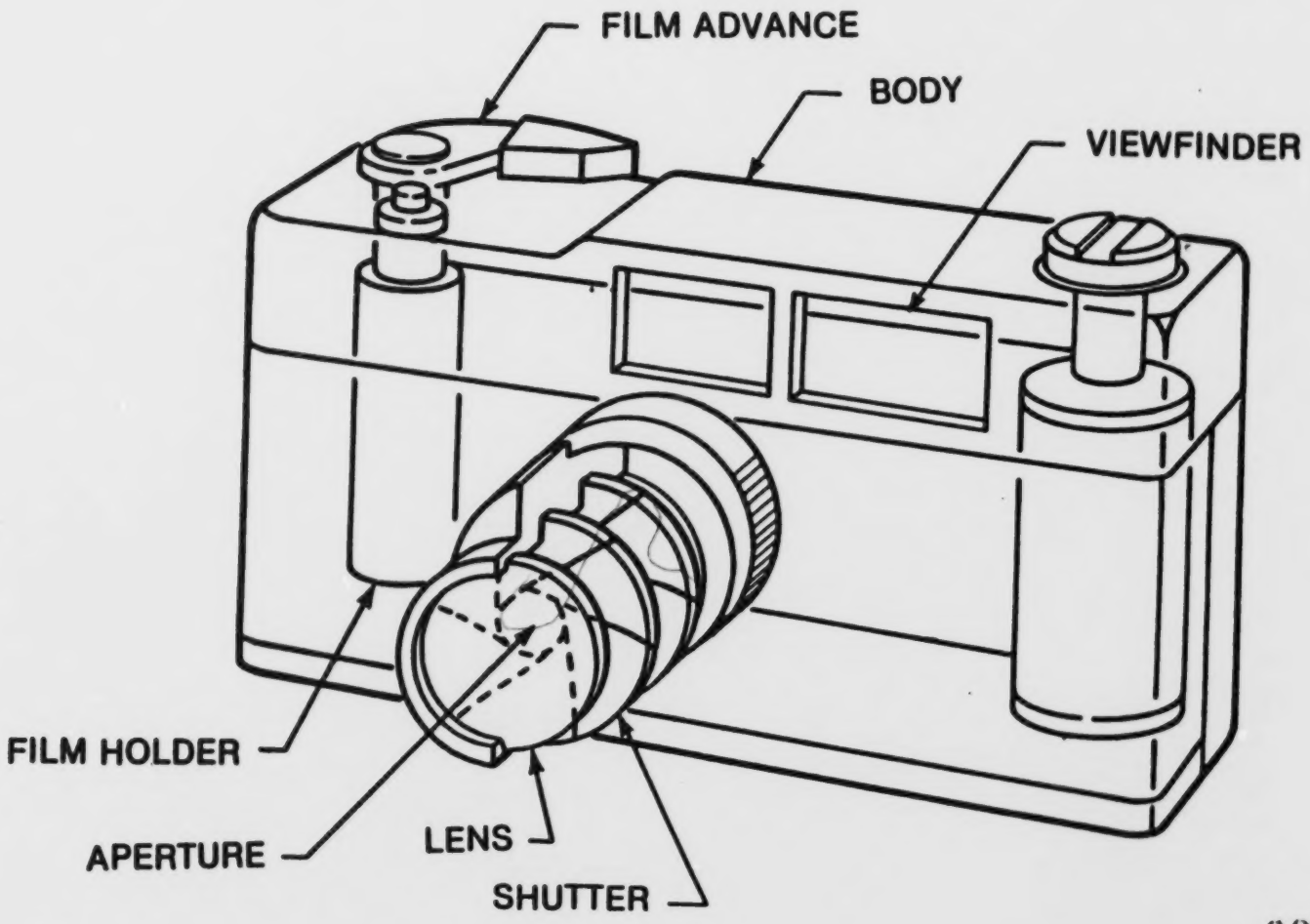
REFRACTION

BEHAVIOR OF LIGHT

## MATH CONCEPT

$$F - STOP = \frac{\text{FOCAL LENGTH OF LENS}}{\text{DIAMETER OF APERATURE}}$$

# CAMERA - BASIC PARTS



TITLE: CRYSTAL RADIO

CATEGORY: SYSTEMS

DESCRIPTION:

The crystal radio is the simplest radio receiver ever developed. It is comprised of an antenna, coil, capacitor, diode, earphone and a good earth ground connection. Because it uses no batteries, it relies on the strength of received radio waves to supply its operating power. Due to its simplicity, it is obviously limited in its sensitivity, frequency selection and output power. Radio receivers used today were developed from this simple radio circuit.

SCIENCE CONCEPTS:

1. In alternating current (A.C.), electrons in the conductor flow in one direction and then reverse direction.

2. A.C. is represented graphically by the sine wave.

3. When electrons flow in a conductor, a magnetic field will radiate from the conductor.

4. The magnetic field produced by alternating current will expand and collapse in step with the alternating current.

5. At 20,000 cycles per second or higher frequencies, the electromagnetic field will travel into space and is called a radio wave.

6. Radio waves travel at the speed of light.

7. As radio waves strike an antenna, a voltage will be induced that will cause current to flow in one direction.

8. As the wave collapses, voltage and current are induced in the opposite direction.

9. Sound waves have a frequency too low to radiate through space.

10. Sound waves can be mixed with radio waves in a process called modulation. Amplitude modulation (am) varies the amplitude of radio waves such that peaks rise and fall at the frequency of the audio waves. The radio waves are known as the carrier waves.

11. Current in an antenna coil will induce current in a secondary coil.

12. A capacitor will store electrical charges. The ability of a capacitor to store charges depends on the area of the plates, the distance between the plates, and the dielectric between the plates.

13. Higher capacitance capacitors require more time to charge than lower capacitance capacitors.

SCIENCE CONCEPTS:

(CONTINUED)

14. Alternating current does not flow through a capacitor but an effective current exists across the capacitor.

15. Variable capacitors have plates which can rotate between stationary plates to increase or decrease plate area and thereby change capacitance.

16. As a capacitor charges, a back voltage builds opposing current. This is capacitive reactance.

17. As current begins to flow through a coil, the growing magnetic field induces a voltage opposing the current. This is inductive reactance.

18. If a capacitor becomes fully charged before the radio wave collapses, the capacitor will repel (stop) any more current flow and cancel the signal.

19. At a certain frequency, capacitive reactance and inductive reactance are equal but opposite. At this frequency the circuit has minimum resistance and maximum current. This frequency is called the resonant frequency.

20. Changing the value of the capacitor changes the frequency of the radio station needed to produce a resonant circuit.

21. A circuit is resonant when the capacitor is fully charged at exactly the same time that the radio waves reverse.

22. Electric current will flow in the direction of minimum resistance.

23. A crystal diode is a detector. Current may flow through the diode in one direction only.

24. Headphones consist of a coil on a permanent magnet and a flexible diaphragm. Current increases and decreases cause the diaphragm to move in and out thereby reproducing sound.

25. As the headphones and the crystal diode are in series, pulsating direct current flows through the headphones.

26. The pull on the headphone's diaphragm varies with frequency and amplitude of the radio signal inducing the current.

TITLE: CRYSTAL RADIO

CATEGORY: SYSTEMS

MATHEMATICAL CONCEPTS:

1. Sine Wave

   Cycle--the complete sine wave from zero through the positive amplitude peak, back to zero, through the negative amplitude peak, and back to zero again.
   Peak-to-peak amplitude is the sum of the absolute values of positive maximum value and the negative maximum value.
   Peak amplitude is one-half the peak-to-peak amplitude.
   Period--the amount of time required for one complete cycle to occur.
   Frequency--the number of complete cycles occurring each second of time.

2. $f = \frac{1}{T}$

   f = frequency in hertz (1 hertz = 1 cycle per second)
   T = time in seconds (period)

3. $X_c = \frac{1}{2\pi fC}$

   $X_c$ = capacitive reactance in ohms
   f = frequency
   C = capacitance in farads

   (Capacitance = 1 farad if a change of 1 volt in 1 second produces 1 amp of current.)

4. $X_L = 2\pi fL$

   $X_L$ = inductive reactance in ohms
   f = frequency
   L = inductance in henrys

   (Inductance = 1 henry if a change of 1 amp in 1 second produces 1 volt ).

5. $f = \frac{1}{2\pi \sqrt{LC}}$

   f = resonant frequency
   L = inductance
   C = capacitance

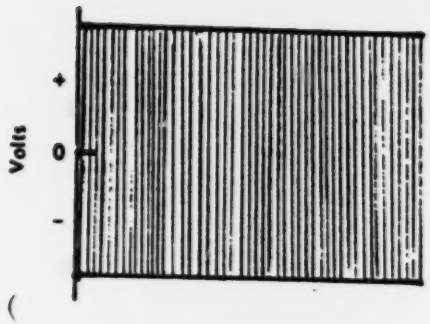
6. $\lambda$ = speed of light/f

   $\lambda$ = wave length in meters
   Speed of light = 3 x 10 meters per second
   f = frequency

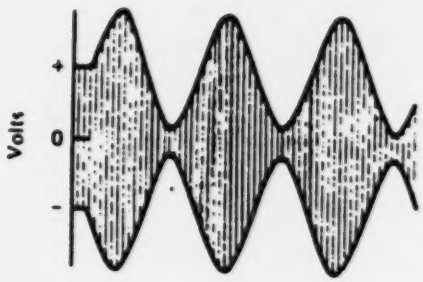
7. T = R x C

   T = time in seconds (T is the time it takes capacitor voltage to rise 63% of its maximum)
   R = resistance in ohms
   C = capacitance

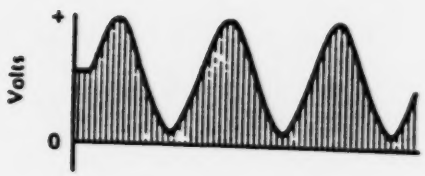
AM RADIO WAVES




UNMODULATED
RF CARRIER

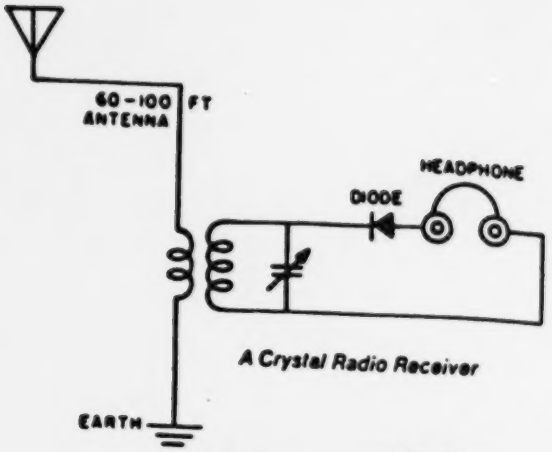



MODULATED
RF CARRIER

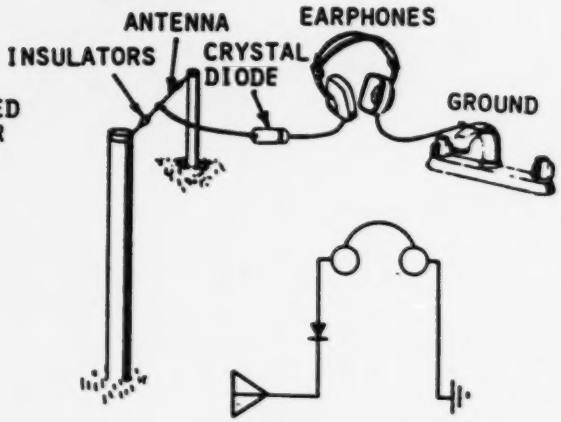



AFTER
DETECTOR

AUDIO OUTPUT
(AFTER FILTERING)

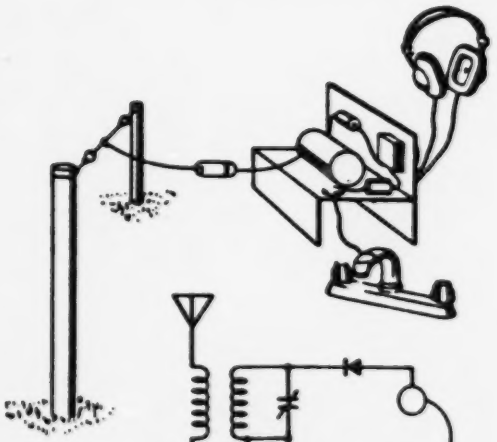


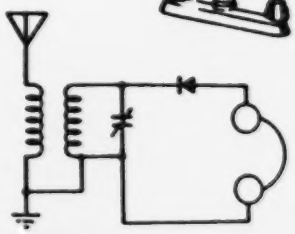

*A Crystal Radio Receiver*






**Simple crystal receiver.**





**Improved crystal set or receiver with tuner.**

BEST COPY AVAILABLE

TITLE: Current Induction in a Dynamic Microphone

DESCRIPTION:

A simplied diagram of a dynamic microphone illustrates the physical relationship between the diaphragm, coil of wire, and magnet. The transfer of energy from sound waves to electrical pulses is presented. A diagram illustrates the process of inducing an electric current in a coil by moving a magnet field into the coil. Farraday's Law is presented to show the relationship of the variables involved in inducing voltage.

SCIENCE CONCEPTS:

1. Understanding the Nature of Sound Waves. Sound is vibration traveling through matter in the form of a wave motion. The matter may be a solid, liquid, or a gas. Air (a gas) is the most important material which transmits sound since air is the medium through which sound is brought to the human ear.

The sound wave is an alternating series of high and low pressure waves moving outward from the source. As these high and low pressure waves strike the diaphragm of the dynamic microphone they induce vibrations, causing the voice coil of the microphone to move in and out along the permanent magnet. This motion induces current in the coil.

2. Understanding how current is induced in a moving coil microphone. When a conductor is moved across a magnetic field, the magnetic field forces free electrons in the conductor to move, producing a current. (The free electrons are from the valence orbits of the conductor atoms.) Thus, mechanical energy is converted into electrical energy when the current flows. This discovery was made by Michael Farraday.

In order to induce current, the conductor and the magnetic field lines must be perpendicular to each other. In a dynamic microphone the coil of wire is the conductor and it's loops are perpendicular to the field lines of the permanent magnet. The induced current will flow at a frequency and amplitude similar to that of the sound waves causing the motion of the diaphragm and coil.

As the diaphragm vibrates it moves the coil in and out along the permanent magnet. When the direction of conductor movement is changed, the current flow changes direction producing an alternating current in the conductor.

TITLE: Current Induction of the Dynamic Microphone

DESCRIPTION:

A simplied diagram of a dynamic microphone illustrates the physical relationship between the diaphgram, coil of wire, and magnet. The transfer of energy from sound waves to electrical pulses is presented. A diagram illustrates the process of inducing an electric current in a coil by moving a magnetic field into the coil. Farraday's Law is presented to show the relationship of the variables involved in inducing voltage.

MATH CONCEPTS:

1. Defining logarithm as an exponent

2. Applying the laws of logarithms:

   a. $\log_b MN = \log_b M + \log_b N$

   b. $\log_b \frac{M}{N} = \log_b M - \log_b N$

   c. $\log_b M^k = k \log M$

   d. $b^{\log_b M} = M$

3. Reading tables of logarithms, base 10

4. Finding the log of a number

5. Determining a number, given its logarithm.

6. Understanding and using exponents as a tool with scientific notation.

7. Applying the formula for decibels, $dB = 10 \log \frac{P_2}{P_1}$

   where $P_2$ = output power in milliwatts and $P_1$ = input power, in milliwatts. In order to compute the power output of a microphone that is rated - 50 d B, or 50 decibels below the zero-decibel reference lever, we have

$$dB = 10 \log P_1/P_2$$

$$-50 = 10 \log P_0/1$$

$$-5 = \text{Log } P_0/1$$

$$-5 = \log P_0 - \log 6$$

$$-5 = \log P_0 - 0.7782$$

$$-5 + .7782 = \log P_0$$

$$-4.2218 = \log P_0$$

$$\frac{10}{5.7782 - 10} = \log P_0$$

$$\text{antilog}(5.7782 - 10) = P_0$$

$$.00006 = P_0$$

Thus, the power output is 0.00006 milliwatts or 0.06 microwatts. $P_i$ was taken to be 6 since a microphone has no electrical power input, its power output is compared at a zero decibel reference level which is usually considered to be .006 watts or 6 milliwatts.

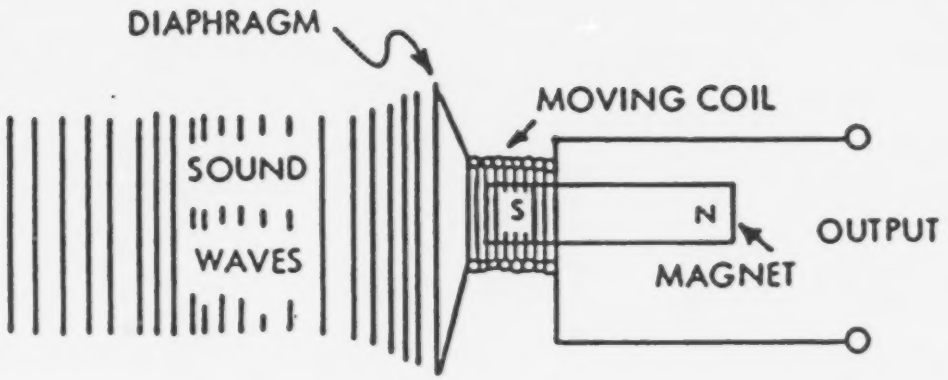
8. Interpreting Farraday's Law: $V_{ind} = N\frac{d\phi}{dt}$ where N is the number of turns and $\frac{d\phi}{dt}$ specifies how fast the flux $\phi$ cuts across the conductor.

9. Showing the relationship between $\frac{\Delta\phi}{\Delta t}$ and $\frac{d\phi}{dt}$

In electronics $\frac{d\phi}{dt}$ means the ratio of the change in flux to the change in time whereas in calculus $\frac{d\phi}{dt}$ represents an infinitesimally small change as $\lim_{\Delta t \to 0} \frac{\Delta\phi}{\Delta t}$

10. Solving Farraday's Law for any of the variables $V_{ind}$, N or $\frac{d\phi}{dt}$ given the other values.

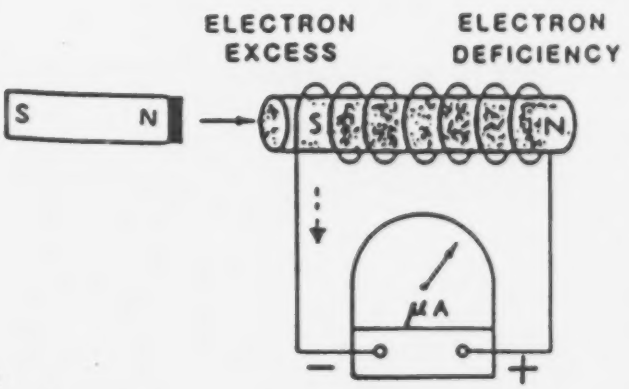
# CURRENT INDUCTION IN A DYNAMIC MICROPHONE




SOUND ➡ DIAPHRAGM ➡ MOTION ➡ ELECTRICAL PULSES ➡

FARADAY'S LAW :

$$V_{ind} = N \frac{d\phi\,(\text{webers})}{dt\,(\text{seconds})}$$




$V_{ind}$ -induced voltage

N -number of turns

$d\phi$ -change in flux

dt -change in time

TITLE: RADIO

CATEGORY: INNOVATION

DESCRIPTION:

The radio receiver is a closed circuit. The radio transmitter sends out the magnetic waves which are converted to the electrical energy in the radio. These radio waves vary in strength at a given rate or speed called frequency. The frequency of the magnetic waves is transformed into alternating electrical energy by the radio receiver at the same frequency. The radio then takes the transformed energy and converts it to sound.

SCIENCE CONCEPTS:

1. Electromagnetic waves are transverse waves that result from the action of electric and magnetic forces.
2. Electromagnetic waves travel through empty space as well as through matter.
3. Electromagnetic waves travel at 186,000 miles per second.
4. In transverse waves the disturbance occurs at right angles to the direction of the wave motion.
5. Energy is transferred from electrical to sound.
6. A magnetic field is said to exist in a region where magnetic forces can act.
7. Electromagnetic induction is the production of an electric current by a changing magnetic field.
8. Frequency, measured in hertz, is the number of crests that pass a point in a second.
9. The speed of a wave equals wavelength times frequency.
10. Reflection is the bouncing back of a wave when it hits a boundary.
11. Amplitude is the distance from a point halfway between the crest and trough straight up to the crest. The larger the amplitude of the wave, the more energy it has.

TITLE: RADIO

CATEGORY: INNOVATION

MATHEMATICAL CONCEPTS:

1. Formulas

$$\text{Frequency (Hz)} = \frac{300{,}000}{\text{wavelength (m)}}$$

$$\text{Frequency (Hz)} = \frac{984{,}000}{\text{wavelength (ft)}}$$

$$\text{Wavelength (m)} = \frac{300{,}000}{\text{frequency (Hz)}}$$

$$\text{Wavelength (ft)} = \frac{984{,}000}{\text{frequency (Hz)}}$$

$$I = \frac{E}{R}$$

$$\text{Amperes} = \frac{\text{voltage}}{\text{ohms (resistance)}}$$

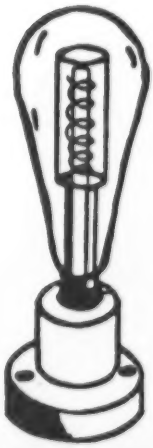
2. Ratio/Proportion
3. Metric system--metric prefixes
4. Angles (degree of reflected waves)
5. Rational numbers

# EARLY RADIO

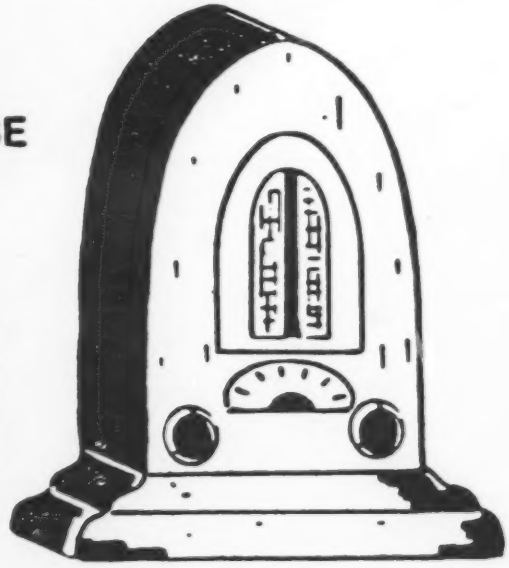
AMPLIFICATION
OF
RADIO SIGNALS

$$\text{FREQUENCY} = \frac{\text{SPEED (m/s)}}{\text{WAVELENGTH (m)}}$$

VACUUM TUBE

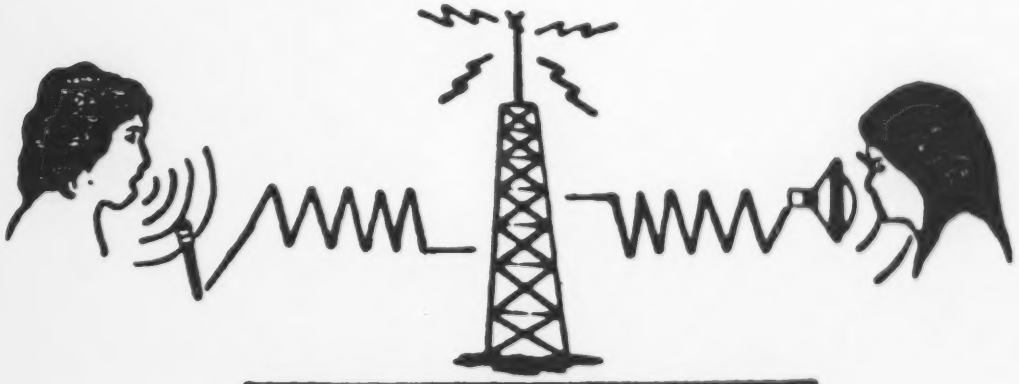


AUDION TUBE



$$\text{OHM'S LAW} \quad I = \frac{E}{R}$$

REFLECTED
WAVES



CONVERSION OF WAVES
SOUND ⟷ ELECTRONIC



BEST COPY AVAILABLE

TITLE: EARLY TELEVISION

CATEGORY: INNOVATION

DESCRIPTION:

The first successful television transmissions were carried out by John L. Baird in the 1920's. He defined television as "The transmission by telegraphy of images of actual scenes with such rapidity that they appear instantaneously to the eye." As the television set was turned on, a beam of electrons was shot out of the electron gun to the dark screen. As each electron hit the screen, it made a dot of light on the screen. Where only a few electrons hit the screen, the picture was black. Where more electrons hit the screen, the picture was gray. Where a lot of electrons hit the screen, the picture was white.

To make the complete picture the beam of electrons started at the top and was shot in a line across the screen. When the beam got to the bottom, it jumped back to the top of the screen to make another picture.

SCIENCE CONCEPTS:

1. Electromagnetic waves are transverse waves that result from the action of electric and magnetic forces.
2. Electromagnetic waves travel through empty space as well as through matter.
3. Electromagnetic waves travel at 186,000 miles/second.
4. In transverse waves, the disturbance occurs at right angles to the direction of the wave motion.
5. Photons are tiny bundles of energy that are given off when excited electrons return to their original energy levels.
6. The photons of electromagnetic waves behave like particles.
7. Electromagnetic waves behave like waves by exhibiting reflection, refraction, diffraction, and interference.
8. Electronic devices have rapid and accurate control of the flow of electrons.
9. Most electronic devices respond to short bursts of electric energy called signals.
10. The first electronic devices were vacuum tubes that contain at least two metal parts. One part is a negatively charged metal wire, while the other part is a positively charged metal plate. When a vacuum tube is put in an electric circuit, electrons are released from the wire and flow to the plate.

TITLE: EARLY TELEVISION

CATEGORY: INNOVATION

MATHEMATICAL CONCEPTS:

1. Formulas

$$\text{Frequency (Hz)} = \frac{\text{Speed (m/s)}}{\text{Wavelength (m)}}$$

$$\text{Wavelength} = \frac{300{,}000 \text{ (m)}}{\text{Frequency (Hz)}}$$

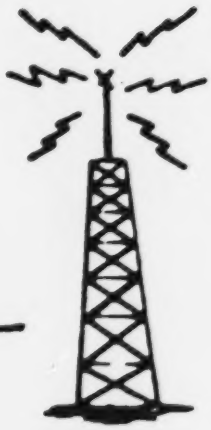
2. Geometry - right angles
3. Metric system
4. Mathematical operations
5. Speed of electromagnetic waves--186,000 miles per second

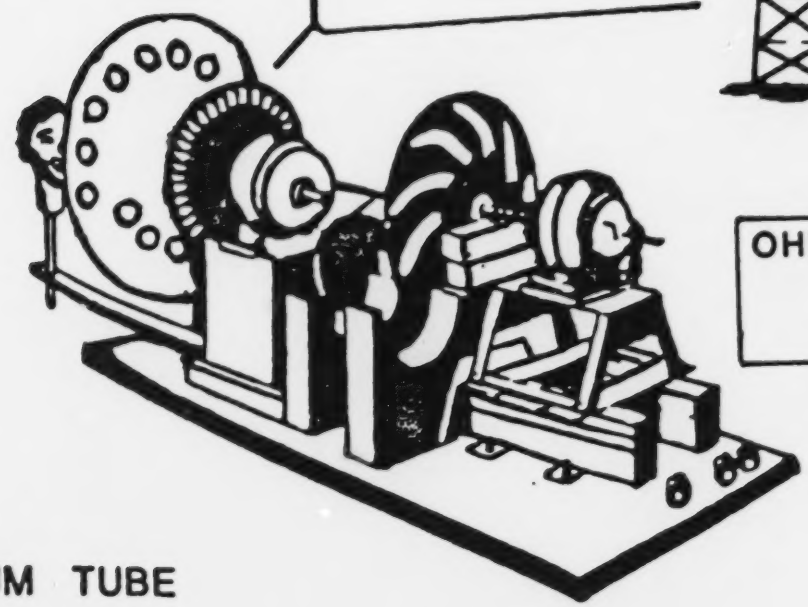
# EARLY TELEVISION

**CONVERSION OF WAVES**

LIGHT ⟷ ELECTRONIC

SOUND ⟷ ELECTRONIC





**OHM'S LAW**

$$I = \frac{E}{R}$$

**VACUUM TUBE**

**AMPLIFICATION OF RADIO SIGNALS**

$$\text{FREQUENCY} = \frac{\text{SPEED (m/s)}}{\text{WAVELENGTH (m)}}$$



BEST COPY AVAILABLE

TITLE: EDISON'S PHONOGRAPH

CATEGORY: INNOVATION

DESCRIPTION:

The first practical phonograph was invented in 1877 by Thomas A. Edison. Edison's phonograph record was a small metal cylinder wrapped in tin foil. It was mounted on an axle that could be rotated. Next to the cylinder was a mouthpiece with a diaphragm. A needle attached to the diaphragm was placed against the cylinder. As someone spoke into the mouthpiece, the cylinder rotated. The sound waves made the diaphragm and needle vibrate causing small dents to be made in the foil. To play the phonograph another needle was attached to a diaphragm which was placed against the cylinder. As the cylinder rotated, the dents in the foil made the needle and diaphragm vibrate thus causing the original sound to be produced.

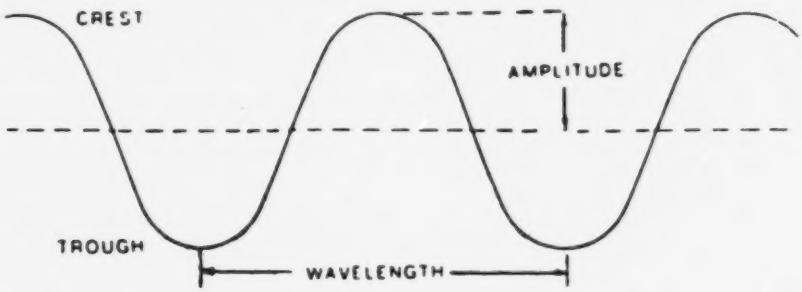
SCIENCE CONCEPTS:

1. Energy is needed to do work.

2. Energy conversion occurs as energy is transferred from mechanical to sound.

3. Sound waves are longitudinal waves.

4. A wave is a disturbance that travels through matter or space.

5. 


Crest is the high point of the wave.
Trough is the low point of the wave.
Wavelength is the distance from crest to crest or trough to trough.
Amplitude is the height of the wave.

6. Friction--a force that acts to slow down a moving object that is passing through or against a material. A force is a push or pull.

7. Fidelity--the accuracy that a system or portion of a system reproduces at its output, the essential characteristics of the signal impressed on its input. (A measure of the exactness with which sound is duplicated or reproduced.)

SCIENCE CONCEPTS:

(CONTINUED)

8. Vibration--a continuously reversing change in the magnitude of a given force.

9. Stylus--the needle-like object used in a sound recorder to cut or emboss the record grooves.
   Stylus drag--the friction between the reproducing stylus and the surface of the recording medium.
   Stylus force--the downward force, in grams or ounces, exerted on the disc by the reproducing stylus.

MATHEMATICAL CONCEPTS:

1. Simple formulas

   $$\text{Mechanical Advantage} = \frac{\text{Load}}{\text{Effort}}$$

2. Rational numbers

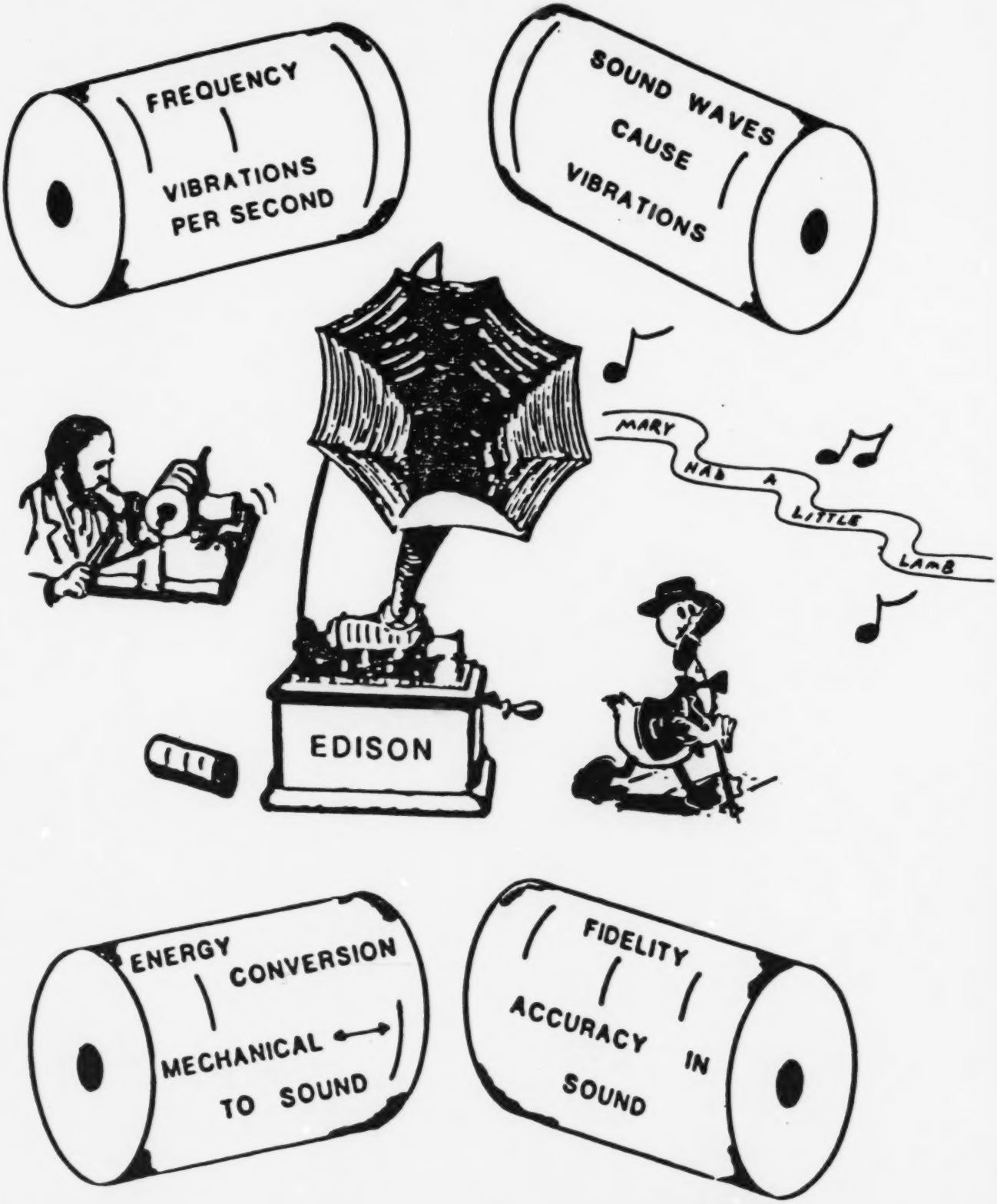
3. Solving equations

4. Mathematical operations

5. Area of circles

6. Volume of cylinder

# EDISON'S PHONOGRAPH






BEST COPY AVAILABLE

Title: Fiber Optics

Category: Innovation

Description:

Scientists working in fiber optics have developed a way to send light through flexible, thin strands of glass or plastic no thicker than the width of your hair and up to 6 miles long. Laser light can pass through the length of an optical fiber and still stay bright. Because optical fibers can serve as pipelines for light, they are also called lightguides. In the mid 1970's, these inventions were teamed together to form fiber optics. Now pulses of light flash through optical fibers carrying information and messages over great distances. Besides communication, optical fibers are used medically. A physician uses a fiber optical medical lightguide in surgery. Veterinarians examine animals with fiber optic scopes. Other applications of fiber optics include teleconferencing, holography, optical computers, and space age communications.

Title: Fiber Optics

Category: Innovation

Science Concepts:

1. The velocity of a light wave equals the product of its velocity times the frequency.
2. Light is composed of tiny packets of energy called photons.
3. Laser is an acronym for Light Amplification by Stimulated Emission of Radiation.
4. Infrared radiation is invisible radiation with a wavelength longer than red light and next to red light in the electromagnetic spectrum.
5. Lasers used in fiber optic telephones use infrared radiation because it can travel long distances through fibers without the loss of power.
6. Light Emitting Diodes (LED) are also being used as a light source because they are cheaper than lasers.
7. Lasers can transmit more information than LEDs.
8. The limit on the number of pulses carried by a fiber is determined by the number of pulses produced by a laser.
   A. AT&T has sent 20 billion pulses/second using multiple lasers.
   B. This compared to a few million pulses carried by a copper wire.
9. A basic communication system consists of a transmitter, information carrier and receiver.
10. The modulator converts the message into the proper format. It impresses the message onto the carrier wave to form a signal.
11. Analog modulation is a continuous signal that reproduces the form of the original message.
12. Digital modulation transmits information in discrete form. The signal is either on or off. The on state represents a digital 1 and the off state represents a digital 0. These states are binary digits.

Title: Fiber Optics

Category: Innovation

Science Concepts:

13. The driver causes the laser to radiate at frequencies where the fibers are efficient transmitters of light.
14. The optic fiber is the information channel, the path between the transmitter and receiver.
    A. The fiber may be glass or plastic fiber, a core, covered with a material of a lower refractive index.
15. The detector converts the optic wave to an electric current.
16. The amplifier also filters the signal. It improves the clarity of the transmission.
17. The decoder transforms the electrical signal into either sound waves or visual images.

Mathematical Concepts:

1) Angles - measuring and drawing
2) $\text{Sin} = \frac{\text{opposite}}{\text{hypotenuse}}$
3) Sine Wave

   Cycle - the complete sine wave from zero through the positive amplitude peak, back to zero, through the negative amplitude peak, and back to zero again.

   Period - the amount of time required for one complete cycle to occur.

   Frequency - the number of complete cycles occurring each second of time.

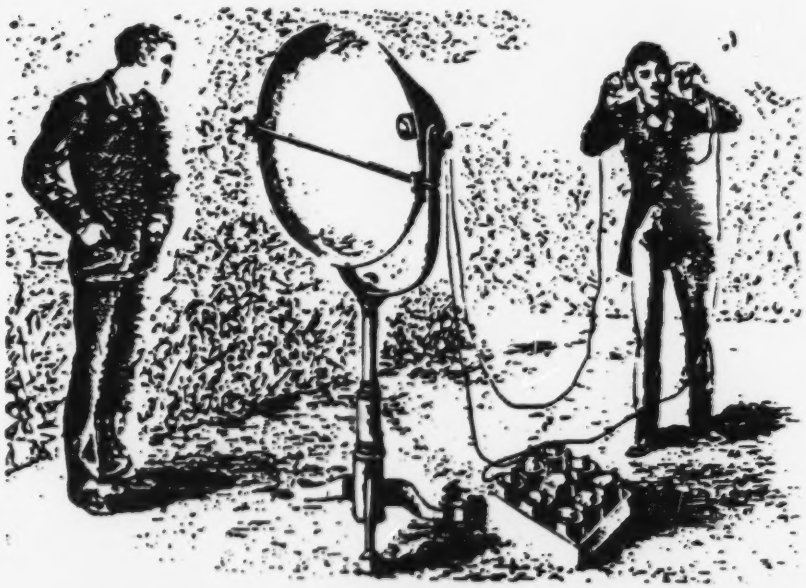
   Phase Shift - the amount by which the curve of the basic equation is shifted.

   Amplitude - the absolute value of either the maximum or minimum value of y.
4) Wavelength - the distance covered by one cycle

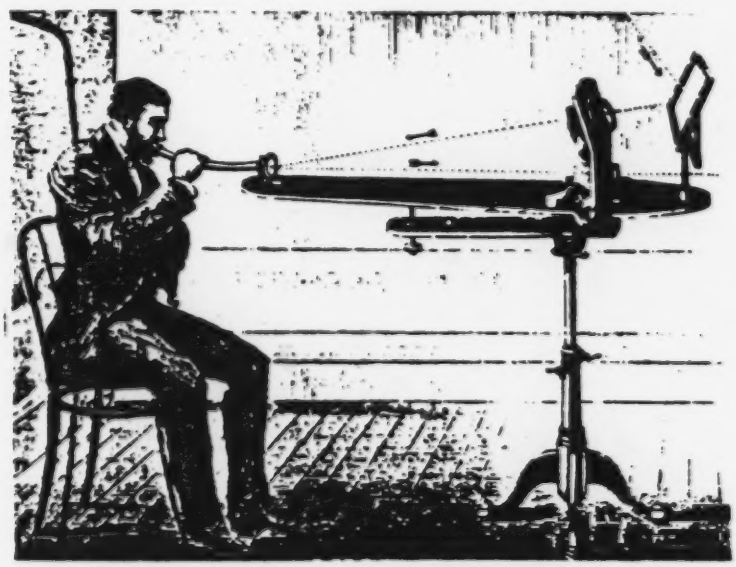
   $\lambda = \frac{\text{velocity}}{\text{frequency}}$
5) Exponents

# FIBER OPTICS

## EARLY COMMUNICATION SYSTEMS



EARLY VOICE TRANSMISSION SYSTEM



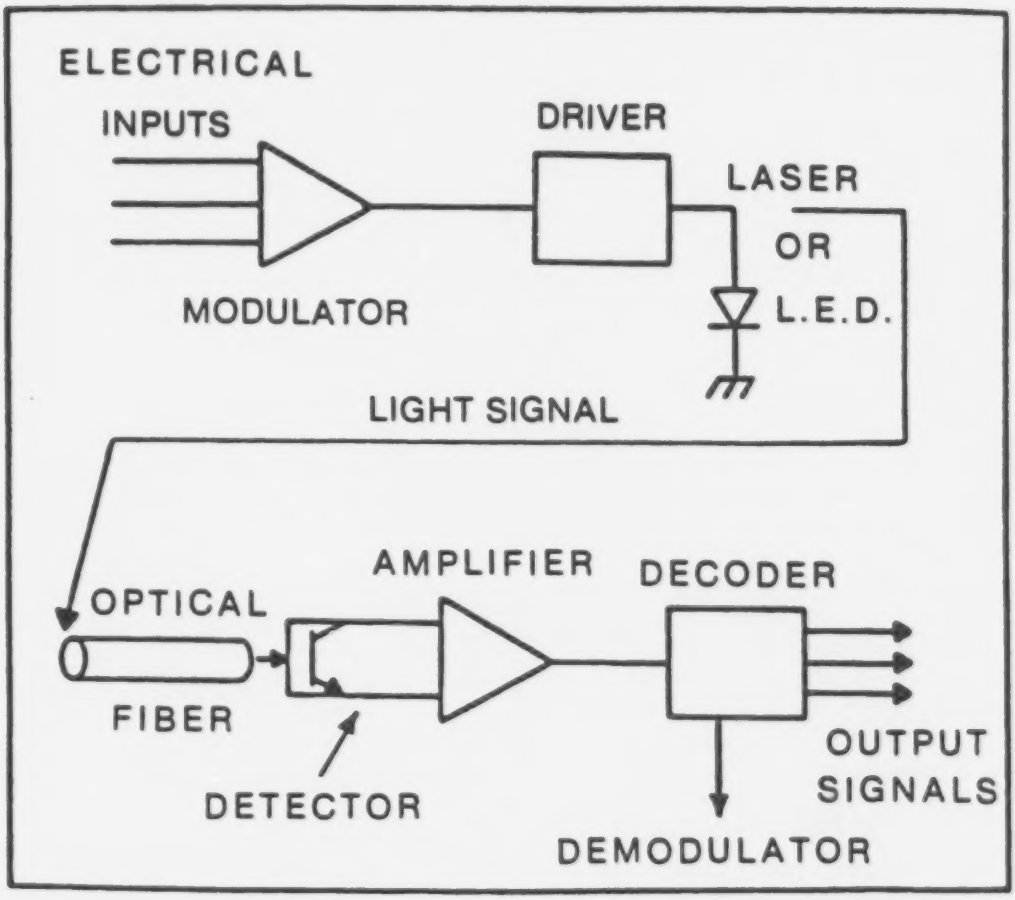
1880 BELL'S PHOTOPHONE



BEST COPY AVAILABLE

# FIBER OPTICS

## GENERALIZED COMMUNICATION SYSTEM




## MATH CONCEPTS

SINE WAVE

ANGLES

$\lambda = v/f$

## SCIENCE CONCEPTS

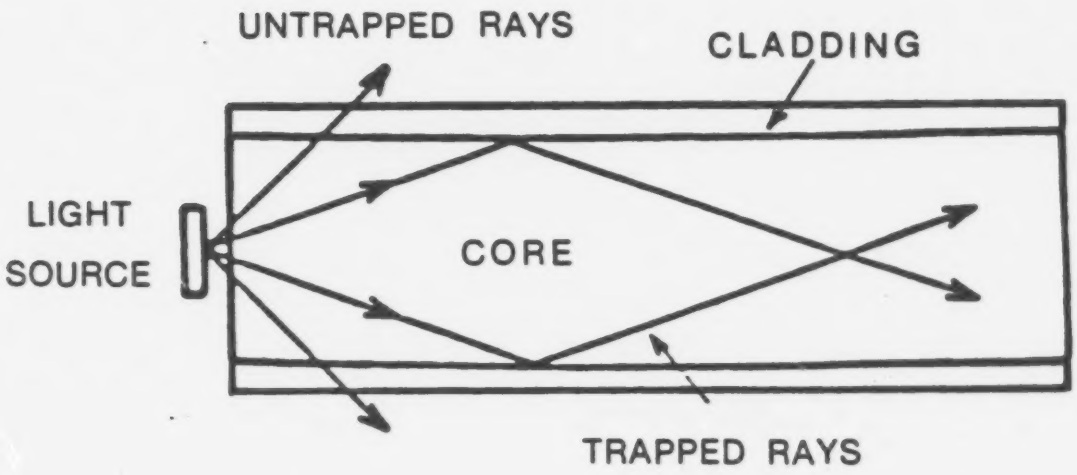
ANALOG MODULATION

DIGITAL MODULATION

L.A.S.E.R.

# FIBER OPTICS

## PASSAGE OF LIGHT THROUGH FIBER




## APPLICATIONS:

COMMUNICATION
MILITARY DEFENSE
MEDICAL PROBES
IMAGE CONDUIT

## FUTURE APPLICATIONS:

SPACE AGE COMMUNICATION
OPTICAL COMPUTERS
HOLOGRAPHY

Title: Holography

Category: Innovation

Description:

Holography was invented by Dennis Gabor in 1947. He called the image recording a "Hologram" from the greek holos gramma - the whole message. Holograms using laser light were developed in the early 1960's. The three types of holograms are 3-dimensional, 2-dimensional (colored foil), and 2-dimensional/3 dimensional. Holograms are printed onto thin plastic which is then aluminized to increase reflectivity. The holograms produced, consist of wave patterns which possess both the amplitude and the phase variations of the object hologramed. In the Soviet Union, a 3-dimensional holographic movie was made. It's only 3½ minutes long and cost over $2 million to make.

Title: Holography

Category: Innovation

Science Concepts:

1. Incident waves are the waves striking an object.
2. Reflected waves are the waves that bounce off the object.
3. The normal is a line perpendicular to the reflective surface.
4. Law of reflection states: Angle of reflection = Angle of Incidence.
5. Refraction is the bending of waves.
6. Refraction always occurs towards the area in which the velocity becomes slower. It occurs in light when the waves passes at an angle from one material to another.
7. Concave lens cause exiting rays to diverse.
8. Interference is the interaction of two or more waves.
9. Destructive interference occurs when the waves are not in phase. The waves cancel each other producing areas of darkness.
10. Constructive interference occurs when the waves are in phase. The waves reinforce each other producing brighter areas.
11. A virtual image is an erect image that cannot be projected.
12. A real image is an inverted image that can be projected.
13. A reconstructed image is a 3-dimensional image formed by reflected light from the hologram. This image maybe real or virtual.
14. The beam splitter is a partially mirrored plane mirror. This allows a portion of the laser beam to be transmitted while the rest is reflected.
15. The split beams must be spread to cover the entire object and film. They must travel equal distances to reach the film from opposite sides. This causes interference and ultimately the reconstructed image.

Title: Holography

Category: Innovation

Mathematical Concepts:

1). Absolute Value

2). Ratios

3). Per cents

4). Higher frequency means shorter wavelength.

Lower frequency means longer wavelength.

5). Wavelength is the distance between one crest in the wave to an adjacent crest.

6). $\lambda$ = Wavelength

V = Velocity

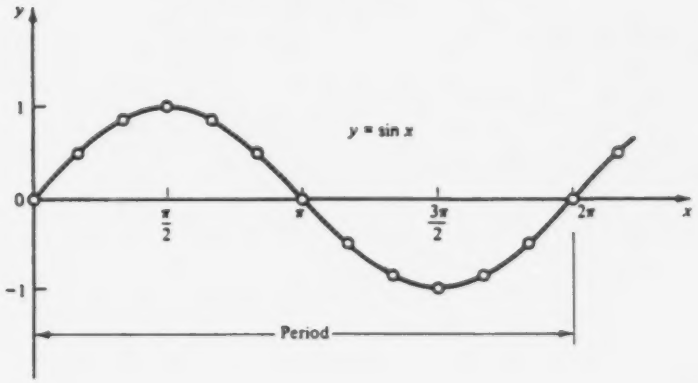
F = Frequency

$\lambda = \frac{V}{F}$

$F = \frac{V}{\lambda}$

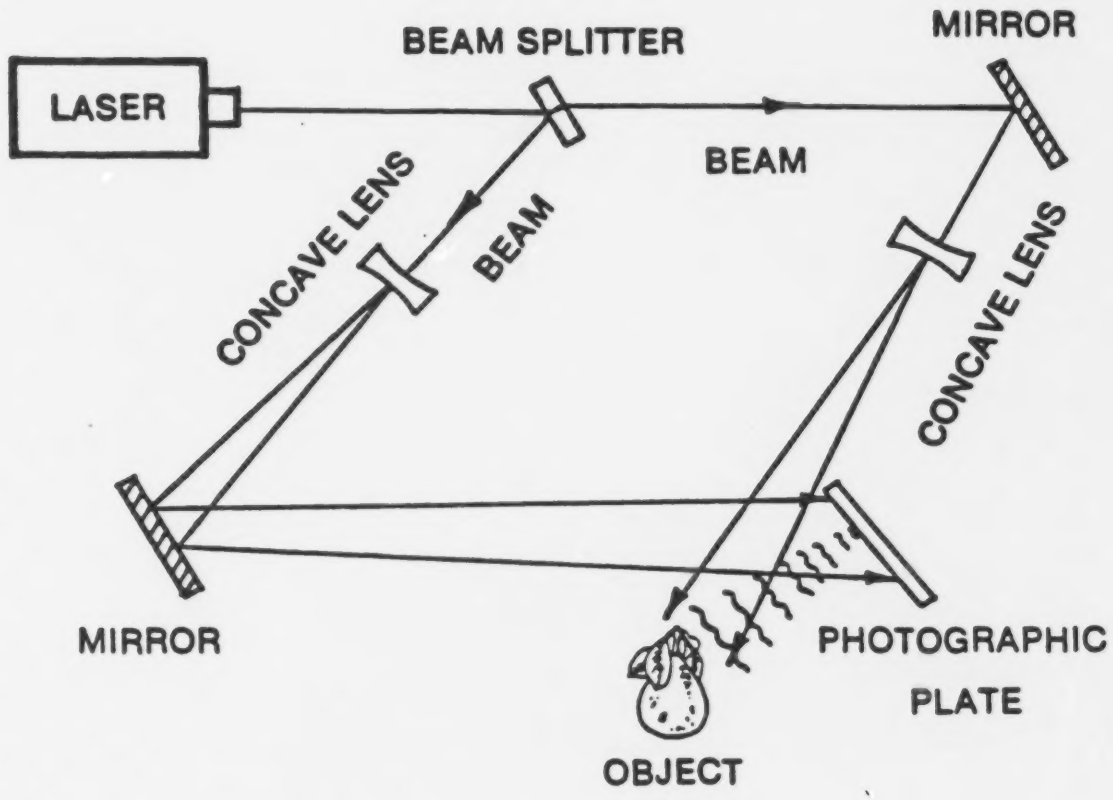
$V = F \cdot \lambda$

7). Sine curve



# HOLOGRAPHY

HOLOGRAPHY IS A PHOTOGRAPHIC TECHNIQUE USING A LASER AS A LIGHT SOURCE TO CREATE A 3-DIMENSIONAL IMAGE ONTO A 2-DIMENSIONAL FILM PLANE CREATING A HOLOGRAM.




## SCIENCE CONCEPTS

LAW OF REFRACTION

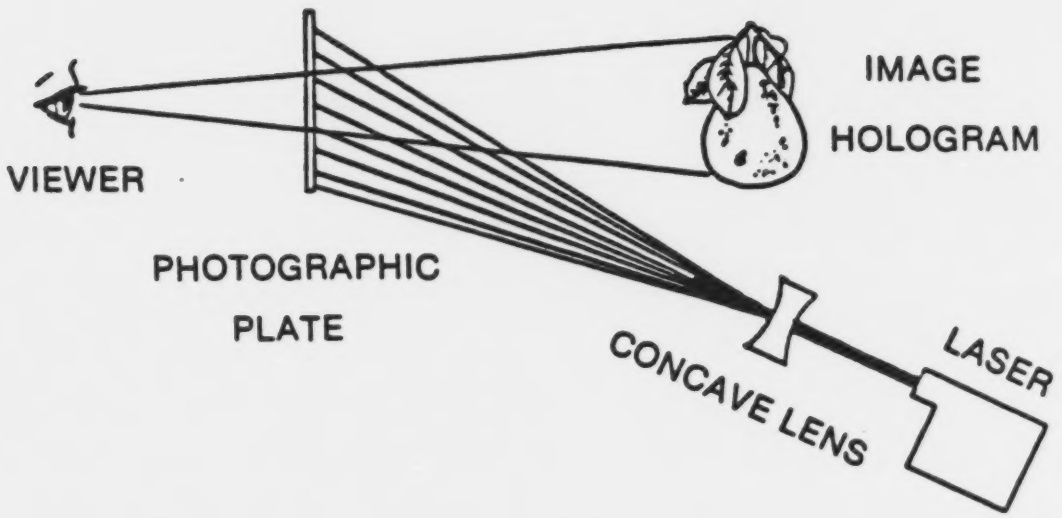
LAW OF REFLECTION

## MATHEMATICAL CONCEPTS

SINE WAVE

$\lambda = v/f$

# HOLOGRAM IMAGE FORMATION




## APPLICATIONS:

SECURITY: CREDIT CARDS AND PASSPORTS
STRESS AND VIBRATION ANALYSIS
PRODUCT DESIGN
PRICE SCANNING
BUSINESS CARDS
GREETING CARDS
LETTERHEADS
BROCHURES
PORTRAITS

## POTENTIAL APPLICATIONS:

TELEPHONE CALLER-IMAGES
COMPUTER-AIDED DESIGN
DATA STORAGE
X-RAY

Title: Lighthouse

Category: Innovation

Description:

The lighthouse has historically been a source of both welcome and warning for mariners. Its primary function is to admonish the navigator of the danger of rocks or shoals as well as to indicate his location. This must be done from as far away as possible hence the need for a most efficient light source. By studying the behavior of light from a scientific perspective, technologists have been able to develop light sources and their projection to maximize the potential of lighthouses.

Title: Lighthouse

Category: Innovation

Science Concepts:

Definitions:

Light - A form of energy that travels in the form of waves.

Photon - The basic particle that makes up light.

Prism - A glass device that is used to bend light.

Reflection - The turning back of waves at the boundary of materials

Refraction - The bending of waves when they pass from one substance to another.

Principles:

1. Light is formed when the potential energy in a substance is changed to kinetic energy during a chemical change such as burning. When the light is created the photons travel in random directions, i.e. toward the sky, ground, etc.
2. An early improvement for concentrating light was the use of the Law of Reflection. The Law of Reflection states that the angle of incidence is equal to the angle of reflection. By placing a reflective surface around the light source a light beam is formed using all the light produced. This beam can then be directed, giving a much brighter light when seen from the direction it is aimed. This reflective surface is a parabolic mirror (catoptric reflector). It is produced in such a way that light from the focal point is all reflected the same direction.

Title: Lighthouse

Category: Innovation

Science Concepts:

Principles:

3. Another way of concentrating the light is using the Law of Refraction. The Law of Refraction states that when light enters one substance from another its path is determined by, $n = c/v$, where n is the index of refraction, c is the speed of light in a vacuum, and v is speed of light in the given material. By using a prism (dioptric prism), light radiating in different directions can be formed into a beam that contains a greater concentration of light.
4. The fresnel lens (catadioptric prism) uses both the Law of Refraction and the Law of Reflection to concentrate the light. The light enters the prism and is refracted to one side of the prism which then reflects the light back out of the prism. By placing a series of concentric prisms at the correct angle to the light nearly all the light from the light source can be concentrated and directed into a beam.

Title: Lighthouse

Category: Innovation

Math Concepts:

1. Law of Reflection - Angles

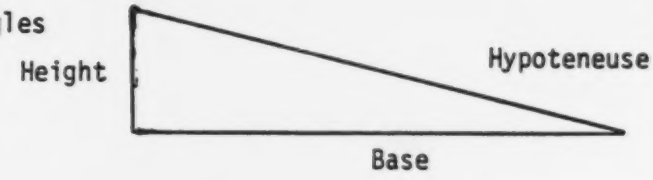
   An angle is formed by two rays with a common end point. As the light beam hits its object an angle is formed with the beam as one ray and a line perpendicular to the object forming the second ray. This is called the angle of reflection. As the light beam reflects off the object, the reflected beam and the perpendicular form the angle of incidence. Several observations can be made about the ensuing angles.

2. Prism is a solid geometric figure with 2 parallel polygonal bases and rectangular faces.

   Prisms used as light reflectors/refractors have triangular bases and three rectangular faces.

   However, prisms can have rectangular, hexoganal or octagonal bases. The number of faces will equal the number of sides on the polygonal base.

3. Right traingles




   Height = height of the lighthouse

   Base = distance from lighthouse to ship

   Hypoteneuse = distance of light ray to ship

   Knowing any two of these values allows us to compute the third using the Pythogorean formula of $a^2 + b^2 = c^2$.

4. Area of circles

   Distance from the light source to the extent of its visibility is the radius of a circle. Using the formula $A = \pi r^2$ we can compute the total land/water area within which the lighthouse can be seen.

Title: Lighthouse

Category: Innovation

Math Skills:

1. Use of protractors

   Distinguishing among kinds of angles

   Naming angles

   Measuring angles

2. Distinguishing among solid geometric figures

   Distinguish among plane figures

3. Define right triangle

   Uses Pythogorean Theorem

   Square roots

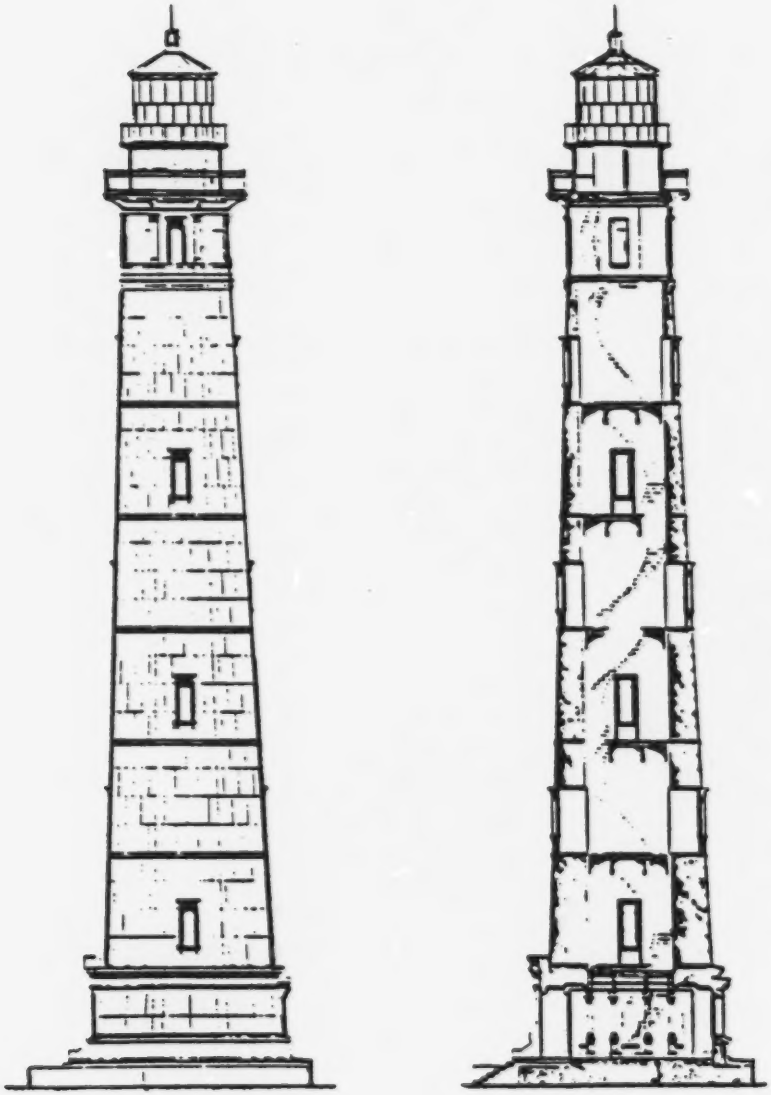
4. Multiplication of decimals

   Squaring numbers

   Area of circles

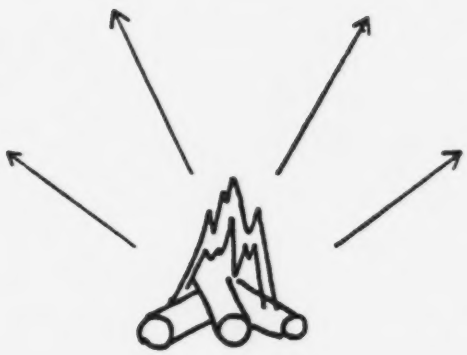
   Distinguish between radius and diameter.

# CAPE HENRY LIGHTHOUSE

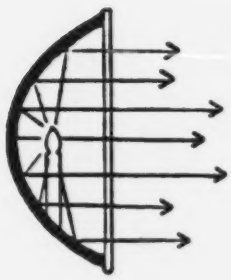


# LIGHTHOUSE

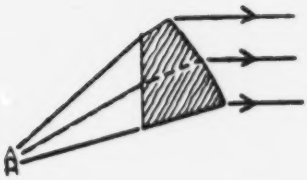
## IMPROVEMENT OF LIGHT BEAM



FIRE



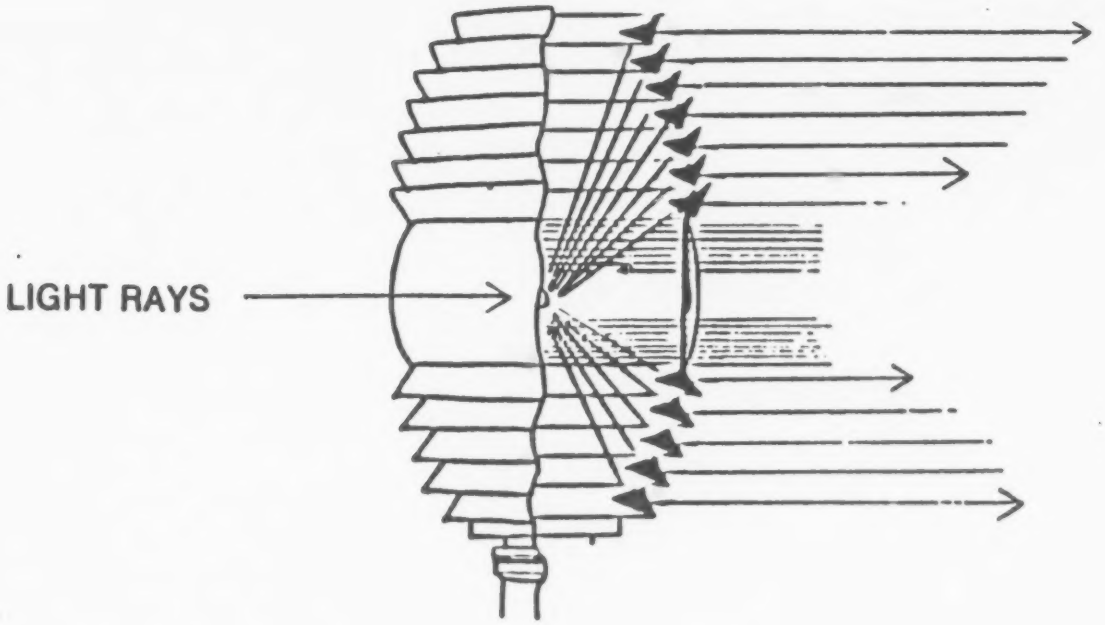
CATOPTRIC REFLECTOR



DIOPTRIC PRISM

CATADIOPTRIC PRISM

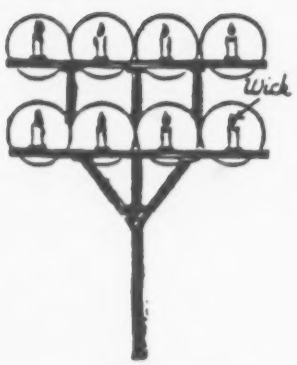
# LIGHTHOUSE




LIGHT PATTERNS IN CATADIOPTRIC LENS

# LIGHTHOUSE

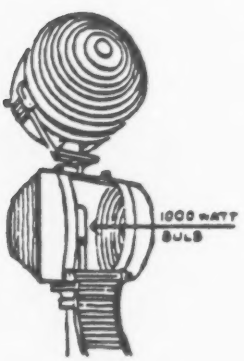
## IMPROVEMENT OF THE LIGHT SOURCE




18th CENTURY
8 CANDLE POWER LAMP

WHALE OIL
LIGHTHOUSE LANTERN

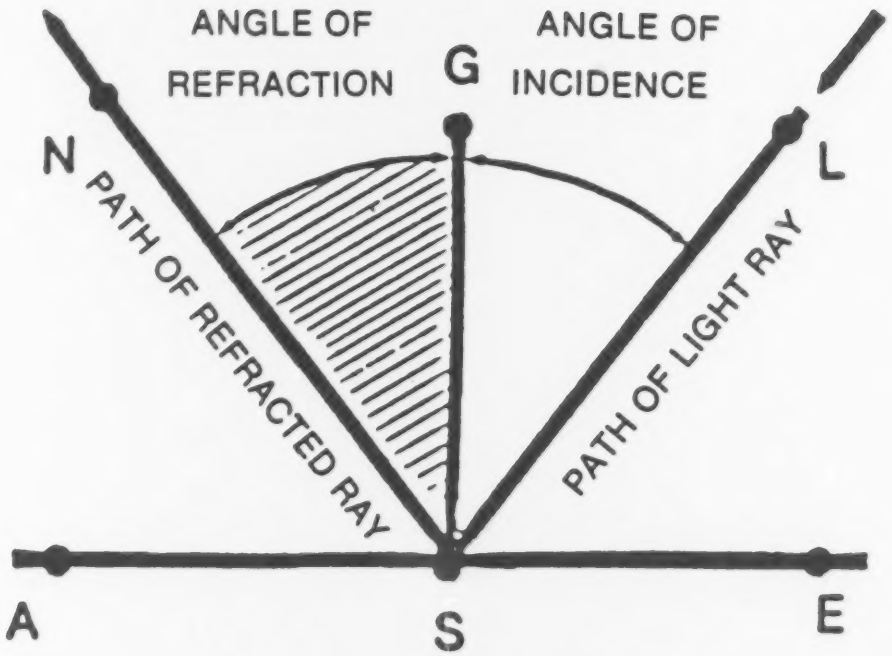
INCANDESCENT OIL BURNER




ELECTRIC BEAM

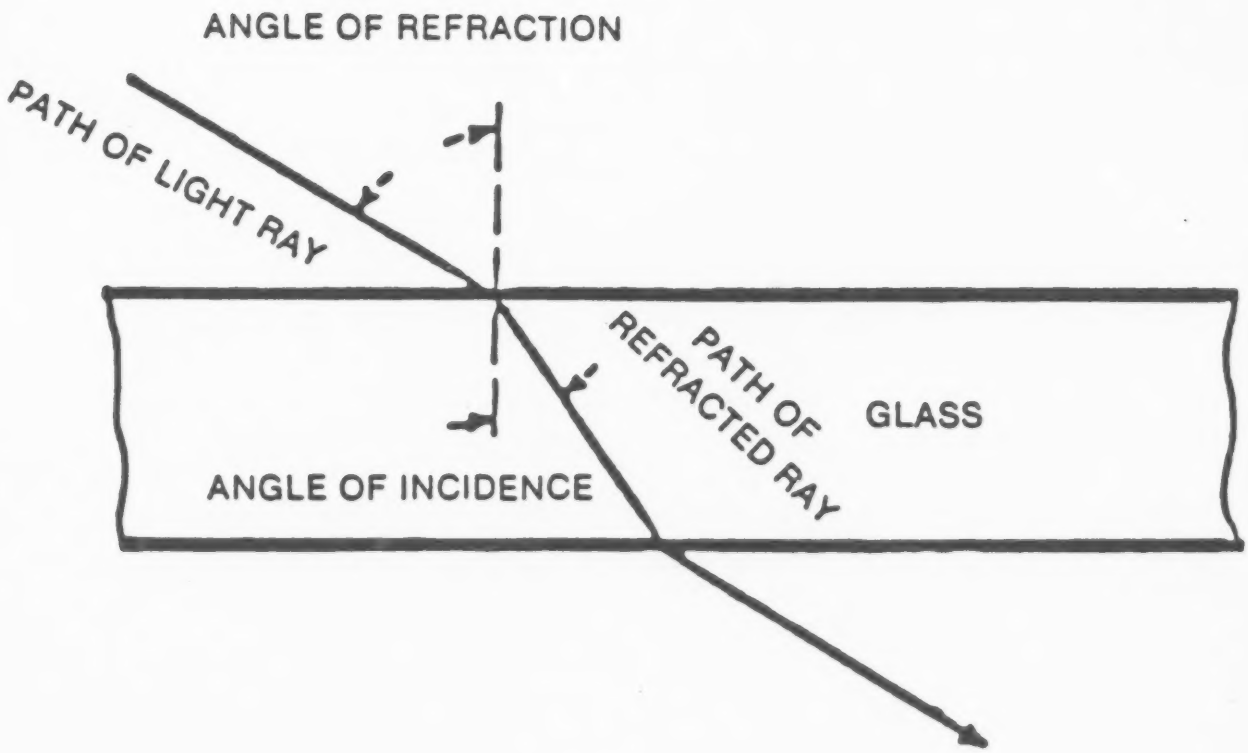
# LIGHTHOUSE

## LAW OF REFLECTION



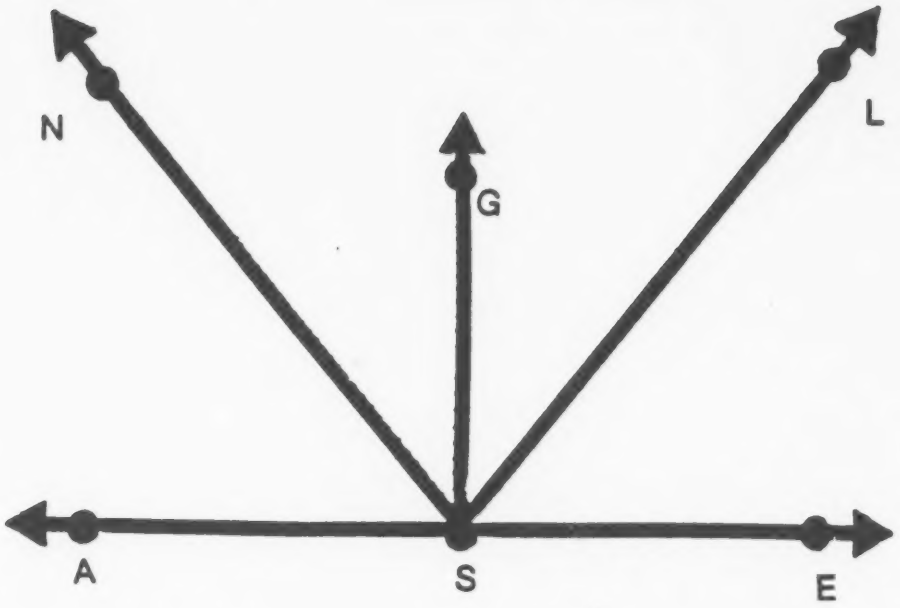
# LIGHTHOUSE

## LAW OF REFRACTION



# LIGHTHOUSE

# ANGLES




COMPLEMENTARY

∠ASN AND ∠NSG

∠GSL AND ∠LSE

SUPPLEMENTARY

∠ASN AND ∠NSE

∠ASG AND ∠GSE

RIGHT

∠ASG ∠GSE

ACUTE

∠NSG ∠GSL

CONGRUENT

∠NSG $\cong$ ∠GSL

∠ASN $\cong$ ∠LSE

Title: Up Periscope

Category: Communication

Description

The students will design and construct a periscope as a vehicle for exploring the behavior of light. Periscopes are built on the same basic principle as the telescope. In its simplest form, it consists of a long tube with a reflecting mirror at each end. The reflecting surfaces are exactly parallel to one another and are arranged at $45^{o}$ angles with the axis of the tube.

Construction of this product can present the opportunity for students to conduct investigations related to light phenomena. Suggested lab stations include reflection on a smooth/rough surface, light refraction through varied mediums, and laser demonstrations.

Title: Up Periscope

Category: Communication

Science Concepts

1. Light usually travels in a straight line.
2. A mirror can be used to change the direction of light. This is called reflection.
3. When a beam of light is reflected from a surface, the striking angle is equal to the reflecting angle. This is the Law of Reflection.
4. The bending of light when it goes from one material to another is called refraction.
5. DIFFRACTION is the ability of light waves to bend around the edges of obstacles in their path.
6. WAVELENGTH: the distance between two crests or two troughs on two successive waves.
7. Frequency refers to the number of waves that move past a point in a given time.
8. PERISCOPES: optical instruments that contain reflecting elements such as mirrors and prisms to permit observation from a position displaced from a direct line of sight.
9. ELECTROMAGNETIC SPECTRUM: the radiation of all known electromagnetic waves ranging from radio waves to cosmic rays.
10. FOCAL LENGTH: the distance from an optical device to the place where the light rays focus in a point.
11. LASER: a device for producing a narrow, monochromatic, coherent beam of light. The term is an acronym for Light Amplification by Stimulation Emission of Radiation.

Title: Up Periscope

Category: Communication

Math Concepts

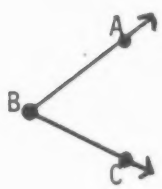
1. $P = 2L + 2W$ Perimeter = (2 x length) + (2 x width)

2. $A = L \times W$ Area = length x width

3. $\frac{\text{OBJECT SIZE}}{\text{IMAGE SIZE}} = \frac{\text{OBJECT DISTANCE}}{\text{IMAGE DISTANCE}}$ The ratio of object size to image is equal to the ratio of object distance to image distance. Use this formula to predict the location or size of an image produced by a lens or mirror.

4. Ratios and proportions

5. Angles

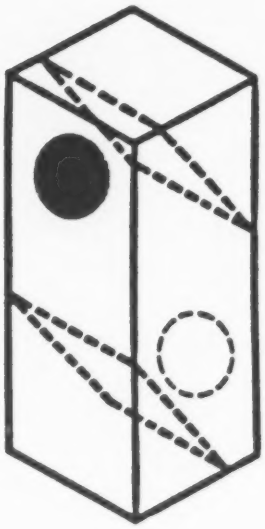



An angle is measured degrees (°). It is a figure formed by two rays with a common endpoint called a vertex. An angle may be denoted by ∠ABC or ∠B. Kinds of angles related to the science concepts include: acute, right, complimentary, supplementary, adjacent, and congruent.

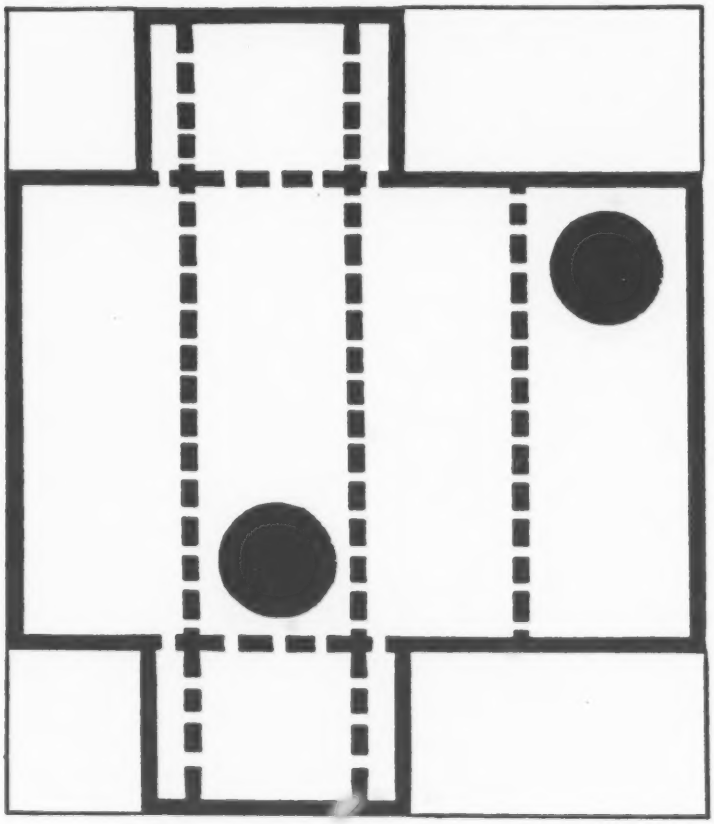
6. angle a = angle b Law of reflection states that the angle of incidence a, always equals the angle of reflection b.

# UP PERISCOPE

PERSPECTIVE VIEW



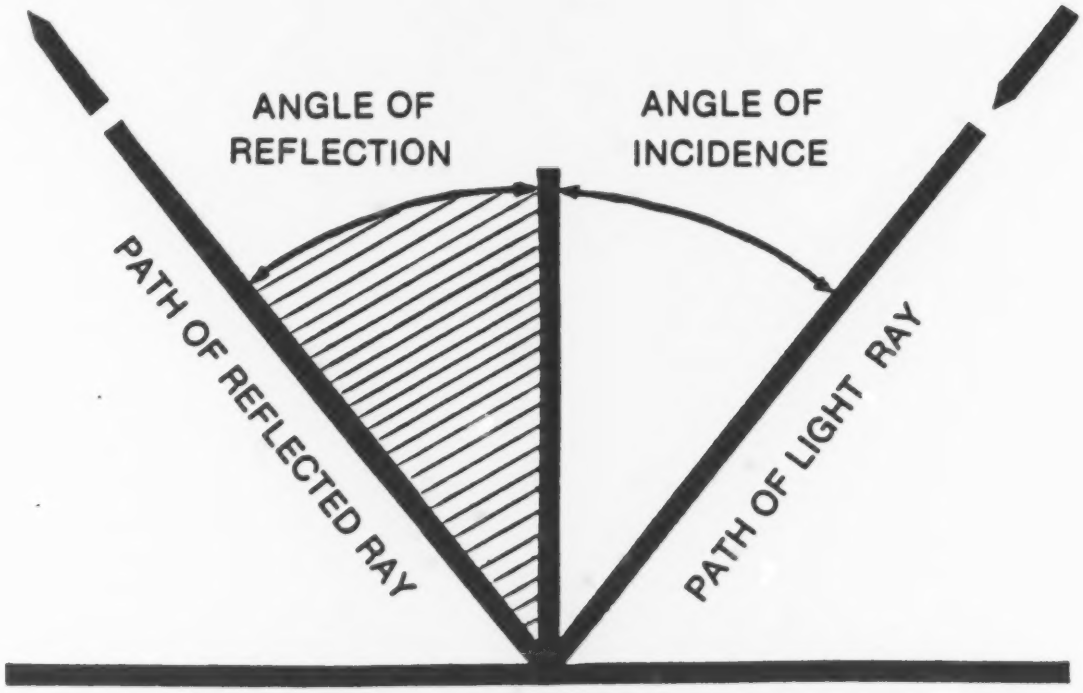
DEVELOPMENT VIEW

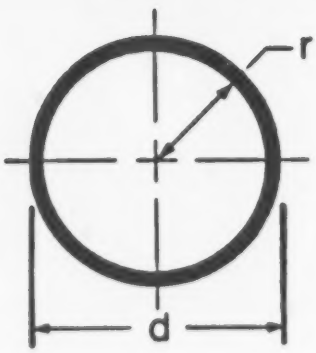


AREA = LENGTH × WIDTH

PERIMETER = 2 × LENGTH + 2 × WIDTH

# UP PERISCOPE

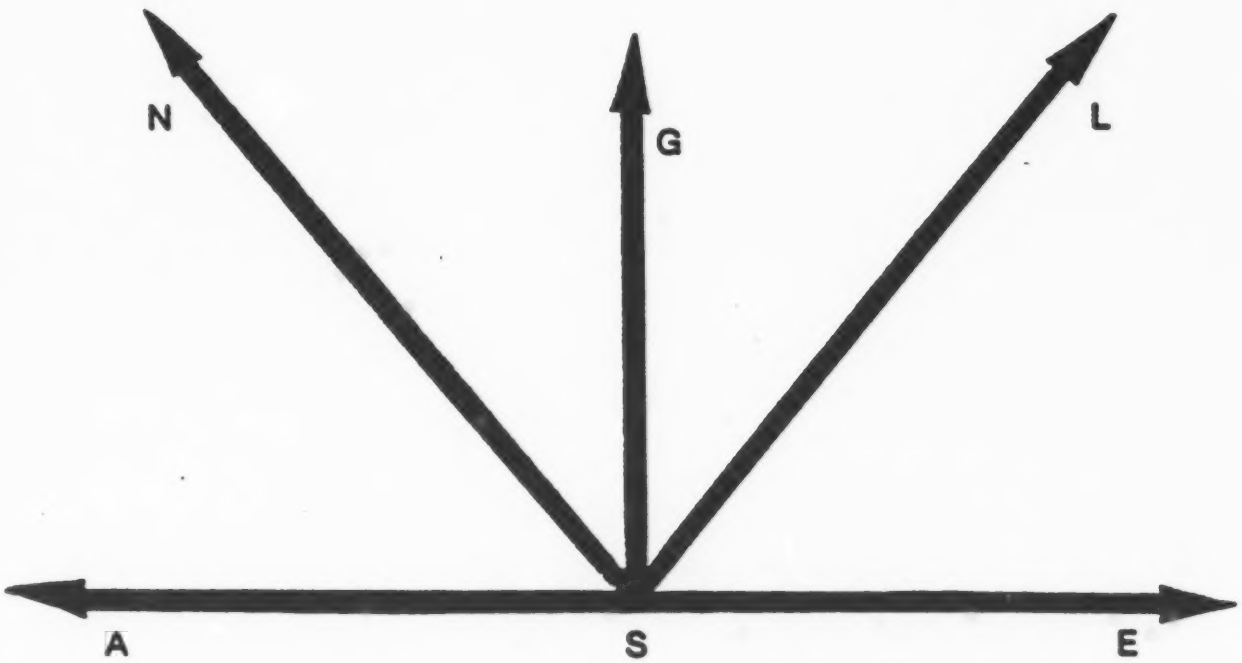



RADIUS = 1/2 DIAMETER

DIAMETER = 2 x RADIUS

# UP PERISCOPE




COMPLEMENTARY

$\angle$ASN AND $\angle$NSG

$\angle$GSL AND $\angle$LSE

SUPPLEMENTARY

$\angle$ASN AND $\angle$NSE

$\angle$ASG AND $\angle$GSE

RIGHT

$\angle$ASG $\angle$GSE

ACUTE

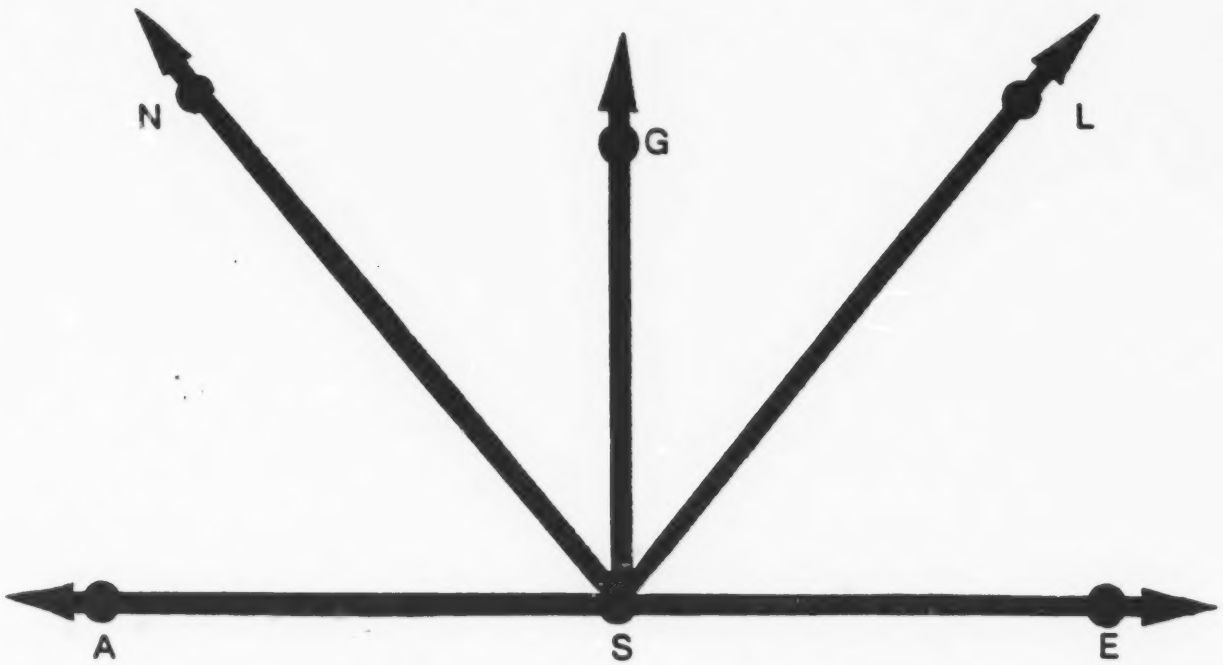
$\angle$NSG $\angle$GSL

CONGRUENT

$\angle$NSG $\cong$ $\angle$GSL

$\angle$ASN $\cong$ $\angle$LSE

# UP Pperiscope




| | |
|---|---|
| COMPLEMENTARY | SUPPLEMENTARY |
| RIGHT | ACUTE |
| CONGRUENT | |

Title: Simple Phonograph

Category: Systems

Description:

A simple phonograph is a system that can reproduce monophonic sound. It is hand operated. It can be made from two circular pieces of woods, a base board, flannel, mica sheet, cement, phonograph needles, pins, metal flange, and an adaptor for the needle. After construction, it can be used to examine the different properties of sound.

Title: Simple Phonograph

Category: Systems

Science Concepts:

1. Sound
   A. Produced by vibrating objects.
   B. Molecules of matter carry sound.
   C. Longitudnal wave movement.
   D. Travels faster in warm air than cold.
   E. Travels faster through solids than liquids
   F. Travels faster through liquids than air.
2. Compression: Region where molecules of air are pushed together.
3. Rarefaction: Area of low pressure left where compression occurs.
4. Wave Motion: Movement of compressions and rarefactions.
5. Longitudnal Wave: Individual molecules in a sound wave vibrate back and forth in the same direction as the wave is moving.
   A. Top of wave represents compressions.
   B. Bottom of wave represents rarefactions.
6. Pitch: Highness or lowness of sound (produced by frequency)
7. Wavelength: Distance from any point on a wave to exactly the same point on the next wave.
8. Frequency: Number of waves, or vibrations, that pass a point in one second.
   A. The faster the source vibrates, the higher the frequency.
   B. The shorter the wavelength, the higher the frequency.
   C. The higher the pitch, the higher the frequency.
9. Amplitude: Size of vibrations - maximum distance that air molecules move. (large amplitude produces loud sound)

Title: Simple Phonograph

Category: Systems

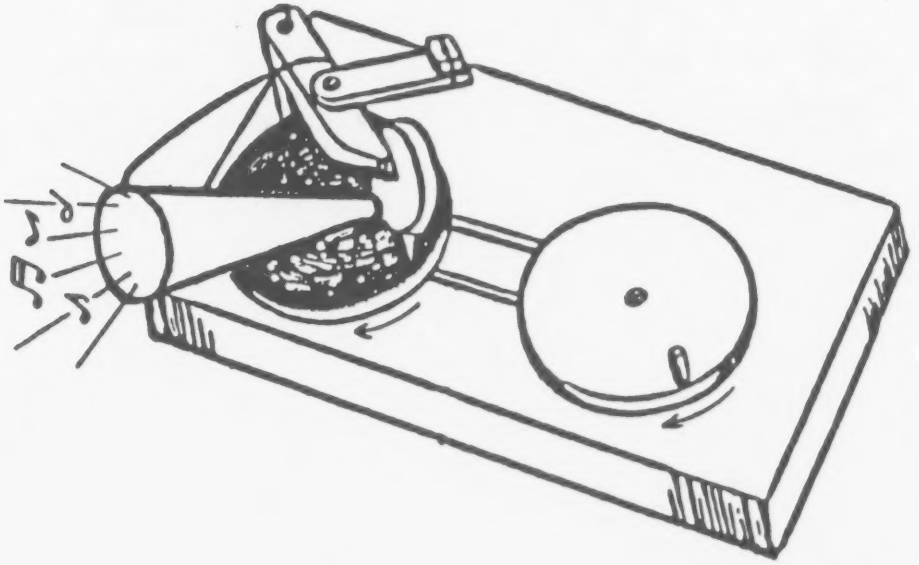
Science Concepts:

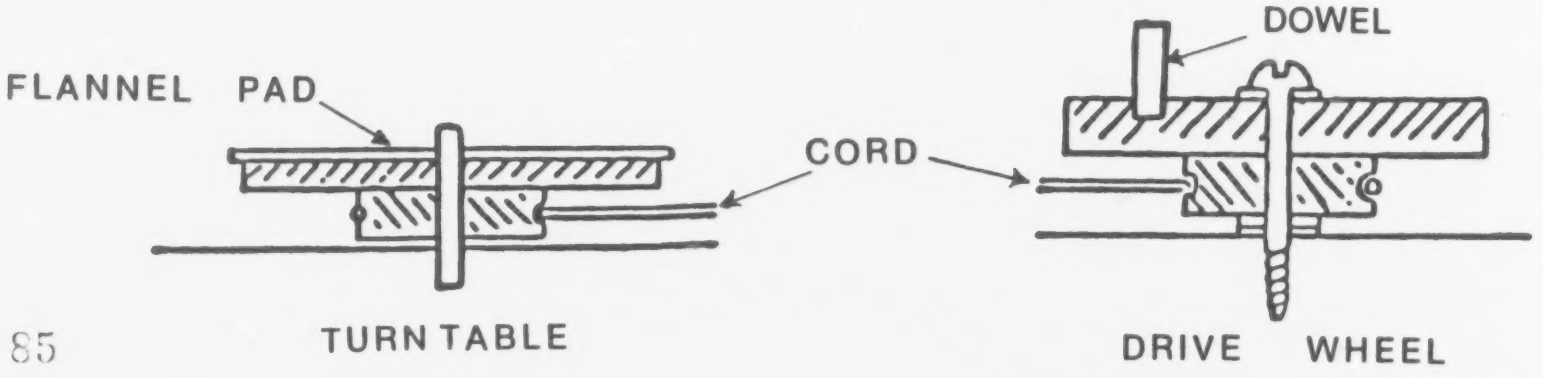
10. Resonance: When sound is reinforced by another object vibrating at the same frequency.
11. Distortion: A change in shape of an audio waveform.
    A. Frequency
    B. Amplitude
    C. Phase
    D. Spatial
    E. Transient
12. Tracking Force: (Needle pressure) - equal to downward force that is exerted on the disc by the needle.
13. Decibel: Represents logarithmically an increase or decrease in sound.
14. Volume: Loudness or Softness of sound (produced by amplitude).

Math Concepts:

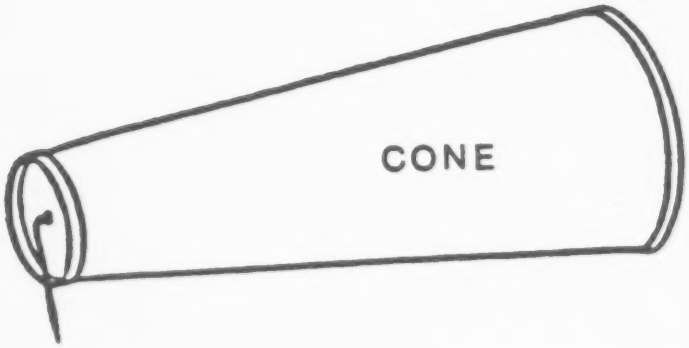
1. Wavelength = Velocity/frequency
2. Speed = Distance/time
3. Increase of speed of sound in air: 60 cm/s per $1^{o}C$
4. Decibels (db) = 10 log (output/input)
5. Logarithms
    A. Common log - base of 10
    B. Reading log tables
6. Multiplying/dividing decimals

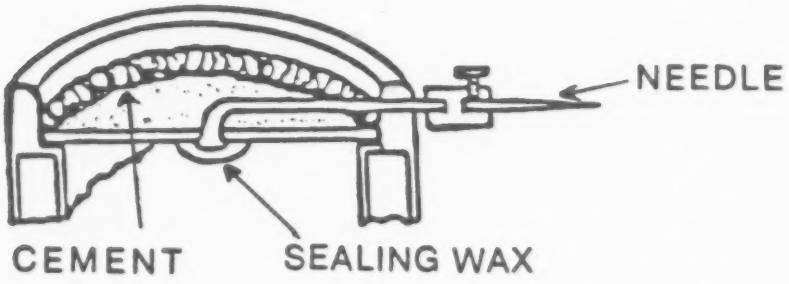
# SIMPLE PHONOGRAPH

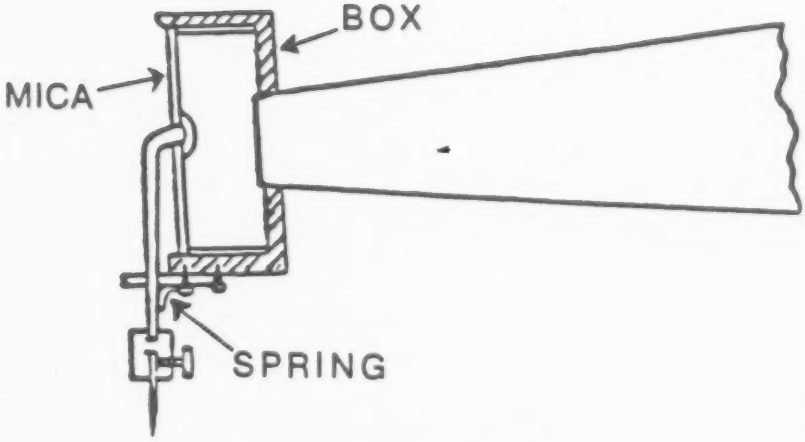




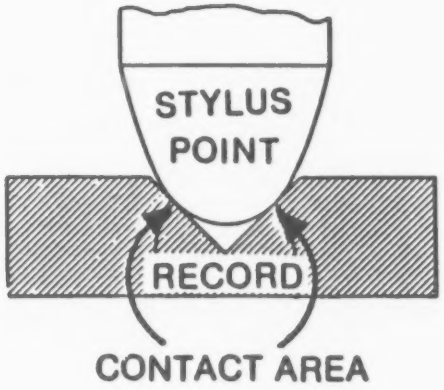
# SIMPLE PHONOGRAPH



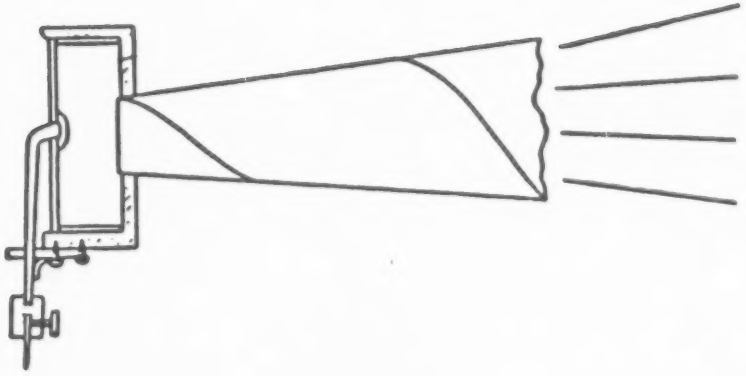



# SIMPLE PHONOGRAPH




MONOPHONIC SOUND - PRODUCED BY A SINGLE CHANNEL DEVICE DESIGNED TO ACCEPT A SOUND AT ITS INPUT AND OUTPUT AN AMPLIFIED VERSION OF THAT SOUND.

# SIMPLE PHONOGRAPH



SCIENCE CONCEPTS

SOUND WAVES

- WAVELENGTH
- FREQUENCY
- AMPLITUDE
- DISTORTIONS
- COMPRESSION
- RAREFACTION

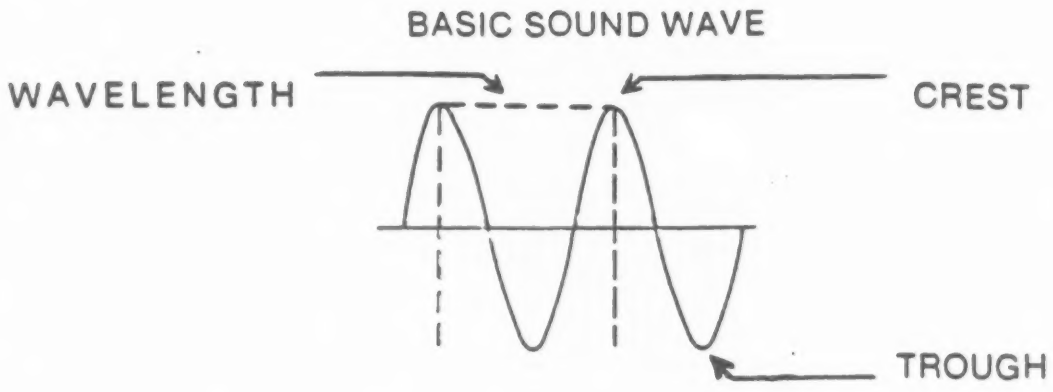
MATH CONCEPTS

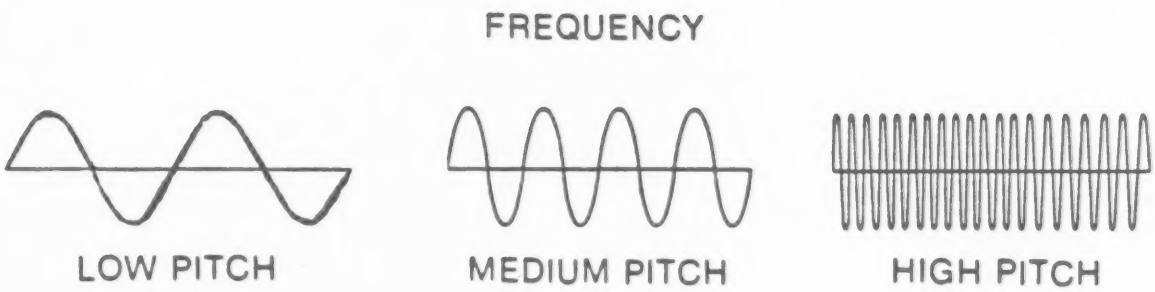
$$\text{WAVELENGTH} = \frac{\text{VELOCITY}}{\text{FREQUENCY}}$$

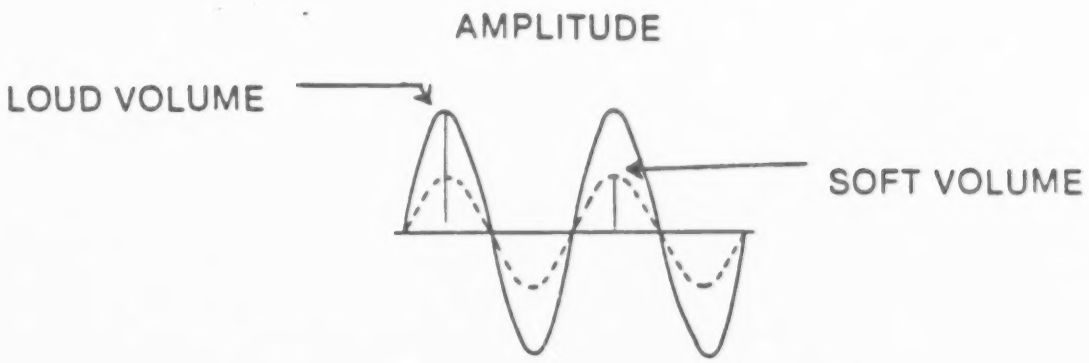
$$\text{DECIBELS} = 10 \log \left( \frac{\text{OUTPUT}}{\text{INPUT}} \right)$$

# SIMPLE PHONOGRAPH

## SOUND WAVES



Title: The Enlarger

Category: Communications

Description:

The process of projection printing or enlarging is similar to projection transparencies with a slide projector. Basically, all enlargers consist of a light source, a means of distributing the light evenly. A negative carrier, a lens, a focusing device, a means of changing the distance of the lens to the negative and an easel for holding the paper.

Science Concepts:

1. Light is energy.
2. Light radiates in all directions.
3. Light travels in straight lines.
4. Light can be refracted.
5. Light can darken a light sensitive emulsion.
6. Convex lenses cause light to converge to a focal point.
7. Both photographic film and photographic paper are photosensitive because they contain silver particles.
8. Various exposure times determine the amount a photosensitive paper will darken.

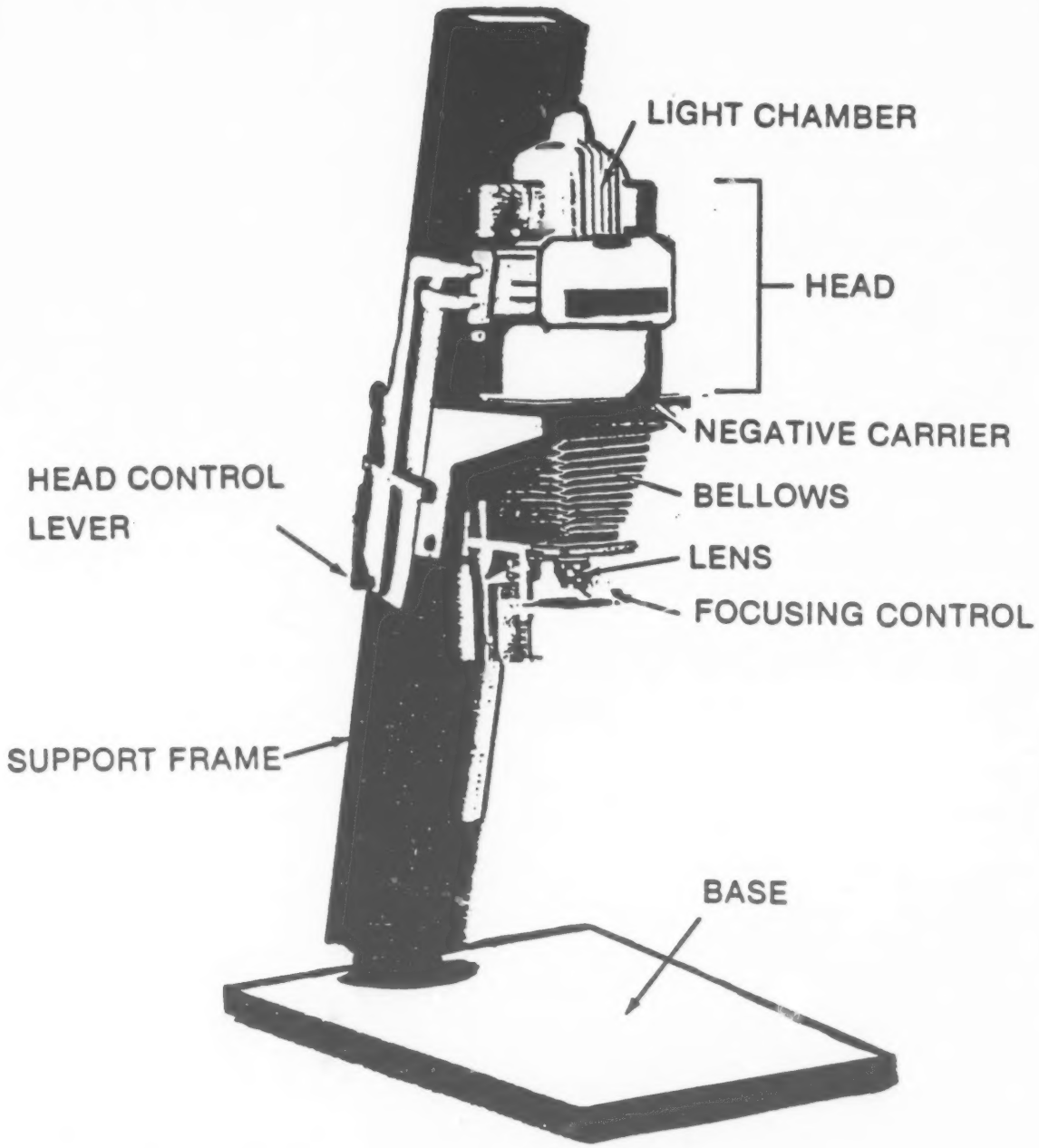
Title: The Enlarger

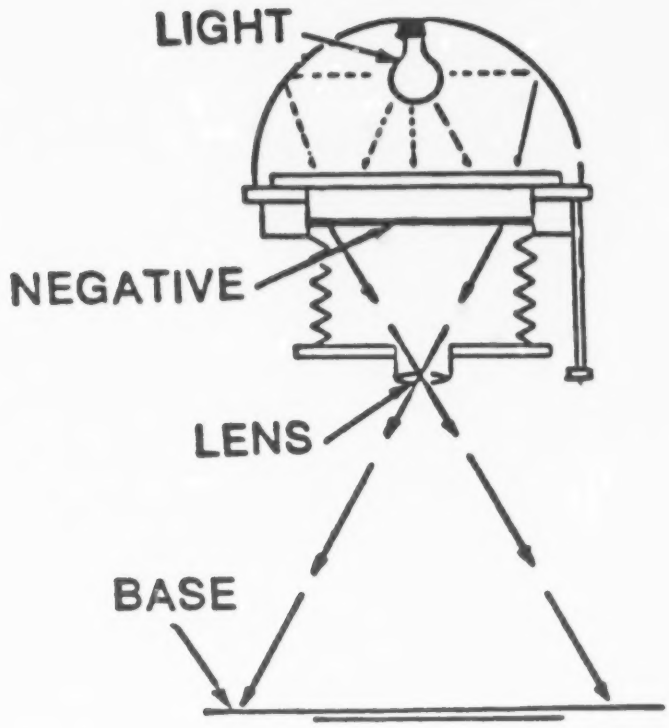
Category: Communications

Math Concepts:

1. Use of ratios and proportions to determine the size of an image.
2. Measurements and adjustment of distance from the base to the enlarger head to get the size (magnification) image desired.
3. Problem solving principles of trial and error when raising or lowering the lamphouse head to change exposure time. As the light source of the enlarger is moved nearer the page, the exposure time decreases. If the light source is moved further from the paper, the exposure time increases.
4. Accurate use of the enlarging timer.
5. Use of the correct grade of enlarging paper. As the contrast grade number gets higher, the contrast of the paper increases.
6. F - stops on enlarger lens controls the amount of light that strikes the enlarging paper.
7. Measuring and centering of the photograph on the base grid.
8. Exposure = Intensity x Time.

# ENLARGER - BASIC PARTS






| MATH CONCEPTS | SCIENCE CONCEPTS |
|---|---|
| PROPORTIONS | LENSES |
| EXPOSURE TIME | REFRACTION |
| PROBLEM SOLVING STRATEGIES | BEHAVIOR OF LIGHT |

Title: Pinhole Photography

Category: R & E

Description:

The pinhole camera is a light - tight enclosure except for the very small hole at one end. Light reflected from the scene being photographed is made up of thousands of small light rays. Some of these image points are reflected through the pinhole (aperture). When the image points pass through the aperture, they are reversed. The image is upside-down and reversed on the focal plane.

Science Concepts:

1. Radiant energy is the energy given off by the sun; an example is visible light.
2. Light is a form of energy which can be received by the eyes.
3. Visible light is a mixture of many different wavelengths. Separation of those wavelengths produces the spectrum (rainbow of colors).
4. Speed of light is 300 million m/sec.
5. Reflection is a property of light in which light bounces off an area or subject.
6. Light striking the photographic paper causes a chemical change to occur on the paper. A chemical change is a change in the chemical makeup of a substance, resulting in a new substance.

Title: Pinhole Photography

Category: R & E

Math Concepts:

1. Measuring
2. Centering
3. Computation of Fractions
4. Developing Tables and Graphs
   A. Data Needed

| Needle Size | Focal Length | F/Stop |
|---|---|---|
| #10 | 6½" (165mm) | F/300 |
| # 4 | 20" (500mm) | F/550 |
| #13 | 2½" (60mm) | F/190 |

   B. Exposure Time
      1. Small Hole - longer exposure time needed
      2. Large Hole - less exposure time needed
5. Recording Data
6. Timing
7. Ratio and Proportion

# PINHOLE CAMERA

TABLES AND GRAPHS

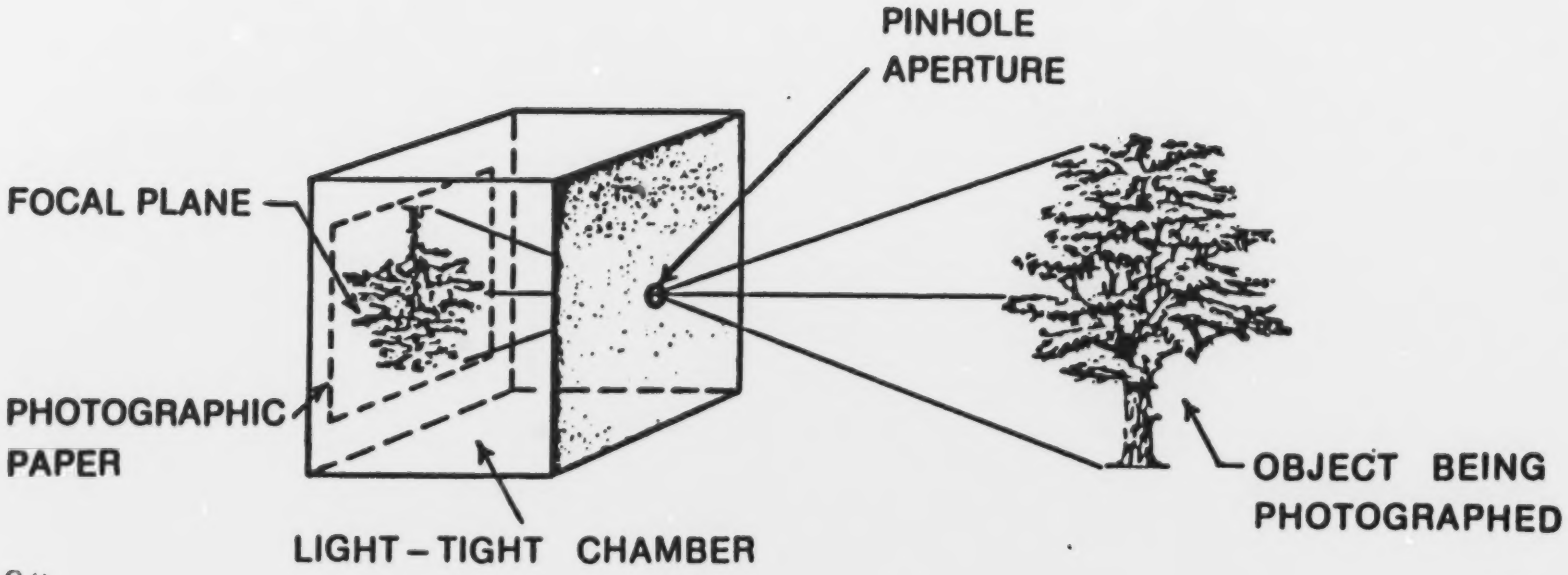
MEASURING

TIME

CHEMICAL CHANGE

REFLECTION

LIGHT



TITLE: PRINTING PRESS

CATEGORY: INNOVATION

DESCRIPTION:

Johannes Guttenberg is credited with the invention of printing from movable metal types. Around 1440 Guttenberg made separate pieces of metal type for each character to be printed. With movable type, a printer could quickly make any number of identical copies of a book. The same pieces of metal type could be used over and over again.

SCIENCE CONCEPTS:

1. Energy is needed for work to be done.

2. Work is the result of a force acting on a body and moving it through a distance. A force is defined as a push or a pull.

3. Simple machine--a device that helps you do work by increasing force, increasing speed or changing the direction of the force.

   Lever and fulcrum--a bar or board that is free to pivot about a fixed point called the fulcrum.

   Screw--a combination of an inclined plane and a cylinder.

   Inclined plane--a simple machine that increases the effort distance through which an object is moved and decreases the effort force needed to move it.

4. Mechanical advantage--a comparison of the force needed to do work directly with the force applied to a machine.

MATHEMATICAL CONCEPTS:

1. Simple formulas

   Unit of work $W=\text{Force} \times \text{Distance}$

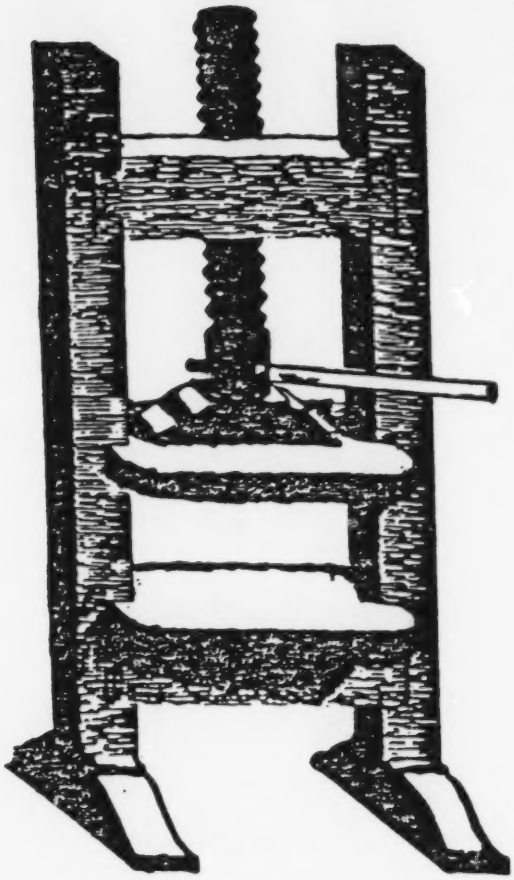
   Mechanical Advantage $MA=\frac{\text{Load}}{\text{Effort}}$

2. Use of decimal numbers

3. Mathematical operations

4. Solving equations

# PRINTING PRESS



MECHANICAL ADVANTAGE...

$$MA = \frac{LOAD}{EFFORT}$$

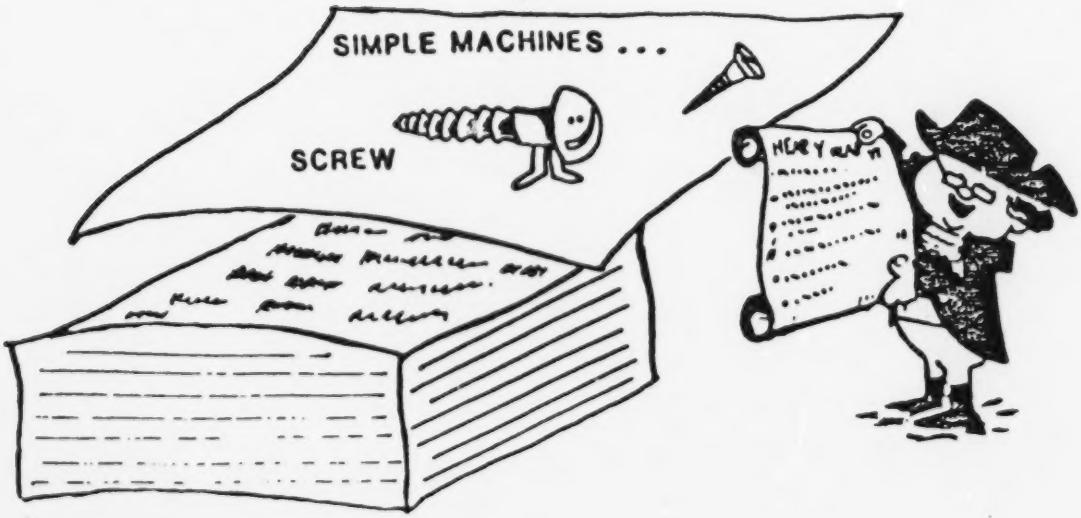
WORK(ft. lbs.) =
FORCE X DISTANCE

NEWS ABOUT:

CLASS I LEVER

SIMPLE MACHINES ...

SCREW



TITLE: TROUBLE SHOOTING

CATEGORY: PROBLEM SOLVING

DESCRIPTION:

Trouble shooting procedures are a form of problem solving requiring knowledge of supporting automotive systems. Trouble shooting charts often serve as a guide to the diagnosis of automotive problems. Trouble shooting charts are organized from the least complex solutions and proceed in flow chart fashion to increasing levels of complexity. Trouble shooting charts suggest both the tests to perform and alternative diagnoses based on test results.

SCIENCE CONCEPTS:

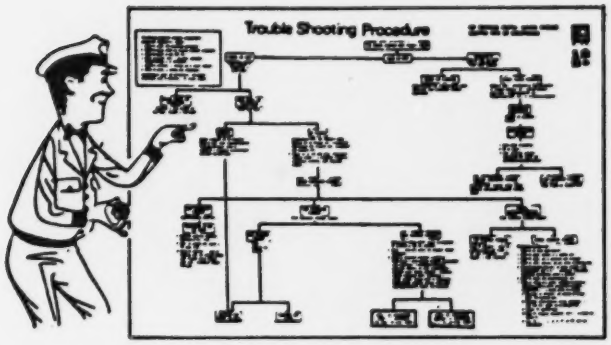
1. Scientists attempt to solve problems.
2. Problem solving involves making observations and gathering information.
3. Problem solving involves making an educated guess (hypothesis).
4. Problem solving involves experimentation.
5. Problem solving involves making measurements and collecting data.
6. Problem solving involves organizing and analyzing data.
7. Problem solving involves writing a conclusion.
8. The search for the solution to one problem often uncovers other problems.

MATHEMATICAL CONCEPTS:

1. The use of organizational skills are important in solving problems.
2. Mathematical concepts and algorithms are involved in solving problems and preparing programs for computers.
3. Flow charts are helpful in solving problems.
4. Reading and understanding facts given in the specific problem are necessary before the problem can be solved.
5. The correct formula to be used in solving the specific problem must be selected.
6. Select the appropriate data to be used in the formula.
7. Solve the formula.
8. Check the result.

# PROBLEM SOLVING

TROUBLE SHOOTING PROCEDURE




## MATH CONCEPTS

FLOW CHART
COMPUTER PROGRAM
IF-THEN
GOTO
AND-OR

## SCIENCE CONCEPTS

SCIENTIFIC METHOD
EXPERT SYSTEMS
DATA ANALYSIS
HYPOTHESIS
EXPERIMENT

TITLE: RADAR

CATEGORY: INNOVATION

DESCRIPTION:

Radar is a device used for transmitting and receiving radio waves to determine the distance and direction of objects in an area. A narrow beam of high frequency radio waves is sent out from a large, dish-shaped reflector by a powerful transmitter. Any object in the path of the radar beam reflects some of these radio waves back to the antenna, where the distance and direction can be determined.

The Doppler effect is used in radar speed-detecting devices. Radar waves are sent out and reflected back from a moving car to a receiver. Changes in frequency of the radar waves are caused by the car moving toward the receiver. The change in frequency is converted to speed by the radar receiver.

SCIENCE CONCEPTS:

1. Radar--high frequency radio wave.
2. Wave--rhythmic disturbance which travels through space or matter.
3. Frequency--number of waves that pass a given point in a given unit of time.
4. The speed of radar waves is 288,000 kilometers per second.
5. Doppler effect--change in wavelength caused by the motion of the sound wave.
6. Echo--a wave that is bounced back by an object.
7. Pitch--how high or low a sound is.

MATHEMATICAL CONCEPTS:

1. The distance, or range, a radar wave travels is calculated from the time taken when the pulse left the transmitter until it returned.

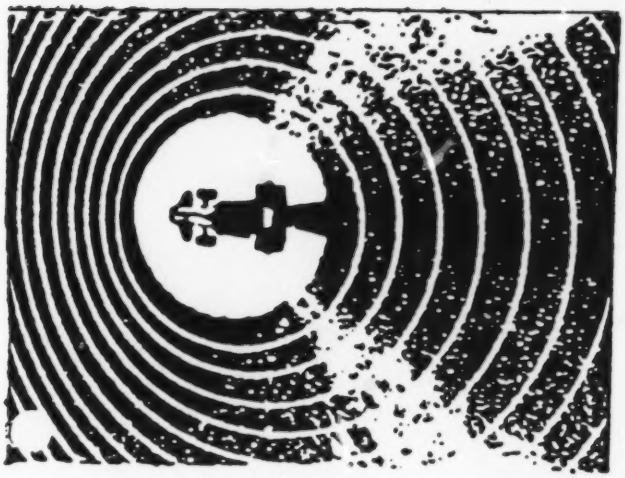
$$\text{Distance} = \frac{(\text{Time} \times \text{Rate})}{2}$$

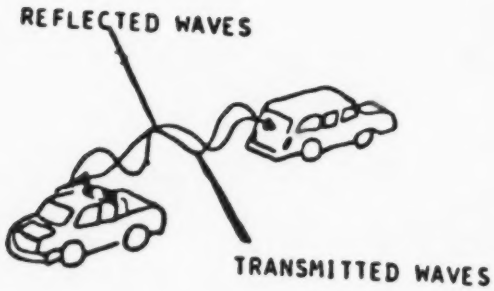
$$\text{Distance} = .2 \times 288{,}000 \qquad \frac{57{,}600 \text{ kilometers}}{2}$$

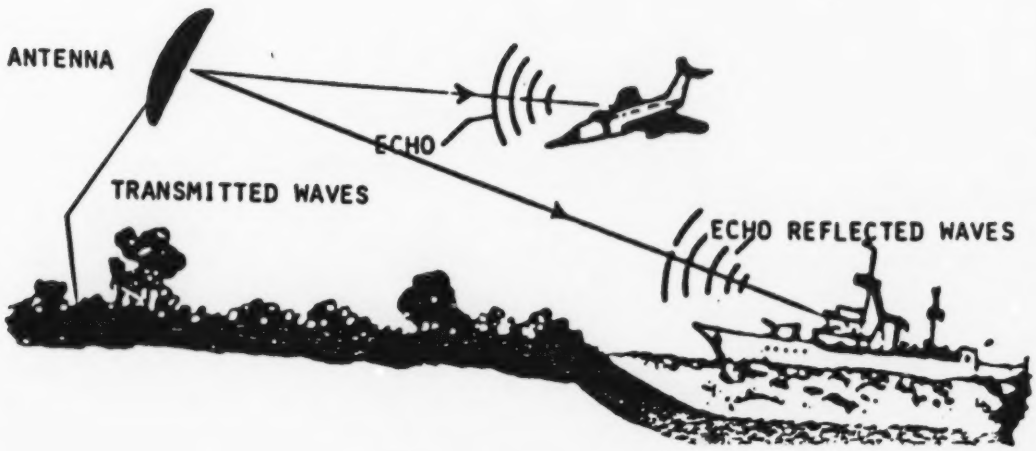
$$\text{Distance} = 28{,}800 \text{ kilometers}$$

# RADAR SYSTEMS

## Doppler Effect





TITLE: THE RADIO SYSTEM

CATEGORY: SYSTEMS

DESCRIPTION:

In 1888, Heinrich Rudolf Hertz, a young German of Frankfort, succeeded in transmitting the first radio wave across a room and picking up this wave signal on an extremely crude type of receiver.

Then followed six years of activity during which a large number of scientists each contributed something new or improved what was already known. These experiments finally led to the wireless telegraph, the first practical radio system. This was invented by Guglielmo Marconi, a young Italian, in 1895. With his system, Marconi was able to send and receive messages for several miles without any intervening wires. In 1901, Marconi succeeded in spanning the Atlantic Ocean.

Here, indeed, was the way to the solution of one of the needs of the twentieth century--a system of communication over long distances without interconnecting wires.

SCIENCE CONCEPTS:

1. Radio--term given to the system of transmission and reception of information by the propagation of electromagnetic radiation as radio waves through space.

2. Energy--ability to do work or cause a change.

3. Wave--energy traveling through a medium by means of vibrations transmitted from particle to particle.

4. Electromagnetic wave--type of wave such as radio, light, and heat, which requires no carrying medium.

5. Radio wave--an electromagnetic wave whose lengths lie between 0.01 cm and 30 km.

6. Carrier wave--smooth sine wave with constant amplitude and frequency.

7. Amplitude modulation--the act of varying the amplitude of a carrier wave by means of an alternating current of low frequency or by a fluctuating direct current.

8. Frequency modulation--a system of transmission and reception where the carrier frequency varies in accordance with the loudness of the audio signal at a rate determined by the frequency of the audio signal.

9. Ion--charged atom produced by the gain or loss of electrons.

10. Ionosphere--charged layer of atmosphere located 60 to 200 miles above the earth's surface.

SCIENCE CONCEPTS:

(CONTINUED)

11. Natural frequency--frequency at which an object will vibrate when struck.

12. Resonance--the condition of two vibrating bodies when the natural frequency of one body is equal to the frequency of the other vibrating body.

13. Electrical potential--the gradient which exists between differently charged areas and which causes a current.

MATHEMATICAL CONCEPTS:

1. Periodic motion is the motion of some vibrating body that occurs at regular time intervals.

2. Sine wave is the shape of a wave pattern that has characteristics related to the sine of an angle.

3. A cycle is a series of changes from normal that are produced as the wave travels in going one wavelength.

4. The wavelength is the distance between one crest in the wave to an adjacent crest.

5. Amplitude is the height of the crest or the depth of the trough measured against the axis of the wave.

6. Frequency is the number of cycles in a given unit of time.

7. Velocity is the rate of speed at which a sound wave travels.

8. Wave Motion Formula:

   Velocity = Frequency x Wavelength

9. Radio waves vary in length from 18 miles down to 1/250 inch. Those used in ordinary broadcasting range from 656 feet to 1968 feet in length.

10. The speed of light is approximately 186,000 miles per second.

# THE RADIO SYSTEM

**MATH CONCEPTS**

PERIODIC MOTION

SINE WAVE

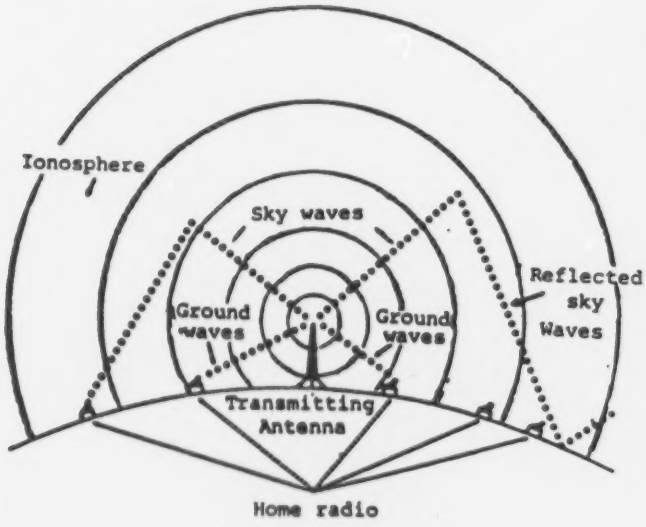
CYCLE

FREQUENCY

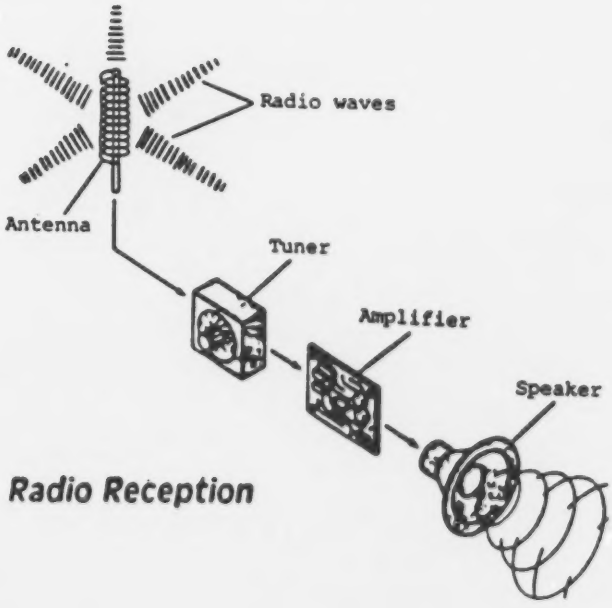
WAVELENGTH

AMPLITUDE

VELOCITY




*Radio Transmission*




*Radio Reception*

**SCIENCE CONCEPTS**

RADIO

ENERGY

WAVE

ELECTROMAGNETIC WAVE

MODULATION

NATURAL FREQUENCY

RESONANCE

TITLE: TELEVISION VIA SATELLITE

CATEGORY: SYSTEMS

DESCRIPTION:

Arthur Clarke suggested a system of relay stations in space, located at a distance of 22,300 miles above the equator of the earth which would rotate at a speed that would keep them in synchronization with one geographical spot on the earth's surface. In effect, the relay station would be "stationary" as the earth rotated. The effect of this suggestion created a space relay station that could be used for transmission of information over the entire earth.

SCIENCE CONCEPTS:

1. The electromagnetic spectrum - a combination of electric and magnetic fields, moving at the speed of light, and composed of numerous frequencies and wavelengths.

The Electromagnetic Spectrum

| Type of Wave or Ray | Frequency, Hertz (Hz) | Wavelength | |
|---|---|---|---|
| | | Meters (m) | Angstrom Units (Å) |
| | 300 000 (300 kHz) | 1000 (1 km) | |
| AM radio | 3 000 000 (3 MHz) | 100 | |
| Radio waves | 30 000 000 (30 MHz) | 10 | |
| TV, FM radio | 300 000 000 (300 MHz) | 1 | |
| | 3 000 000 000 (3 GHz) | 0.100 (100 mm) | |
| Microwaves | 30 000 000 000 (30 GHz) | 0.010 (10 mm) | |
| | 300 000 000 000 (300 GHz) | 0.001 (1 mm) | |
| | 3 000 000 000 000 (3 THz) | 0.000 100 (100 μm) | |
| Infrared or heat rays | 30 000 000 000 000 (30 THz) | 0.000 010 (10 μm) | 100 000 |
| Visible light rays | 300 000 000 000 000 (300 THz) | 0.000 001 (1 μm) | 10 000 |
| Ultraviolet rays | 3 000 000 000 000 000 (3000 THz) | 0.000 000 100 (100 nm) | 1 000 |
| X-rays | | | |
| Gamma rays | | | |

Satellite T. V. uses frequencies between 3.7 to 6.4 $GH_z$ which are in the so-called microwave region of the spectrum.

TITLE: TELEVISION VIA SATELLITE

CATEGORY: SYSTEMS

SCIENCE CONCEPTS CONTINUED:

2. Energy conversion occurs as light and sound are converted to electrical, to microwave, to electrical, and back to light and sound.

3. Geosynchronous Orbit - satellite is positioned at an altitude of 22,300 miles and maintains its position relative to the earth's surface.

4. Reflectance of the receiving dish antennae is dependent upon its shape and the material of which it is constructed.

5. Based on the rule that the angle of incidence is equal to the angle of reflection, the parabolic shape of a dish antenna focuses all incoming waves on a common focal point.

6. Dish material may be machined metal, metal-impregnated fiberglass, or screen wire.

TITLE: TELEVISION VIA SATELLITE

CATEGORY: SYSTEMS

MATHEMATICS CONCEPTS:

1. A parabola is a set of points equidistant from a fixed point and a fixed line.
2. Focal Point is the point at which all reflected signals converge.
3. Directrix is the fixed line given in the above definition. The perpendicular distance between the directrix and the focal point determines how open/"wide" or closed/narrow the parabola will be.
4. Vertex is the midpoint of the perpendicular line segment between the directrix and the focal point.
5. Axis of symmetry is the imaginary line which passes through the vertex and the focal point.
6. The graph of the equation $Y = A X^2 + B X + C$ will yield various parabolas depending upon the values of A, B, and C.
7. A circle is a set of points equidistant from a fixed point.
8. Center is the fixed point in the circle.
9. Radius is the distance from the center to a point on the circle.
10. Diameter is the distance measured across the circle through the center.
11. Circumference is the distance around the circle.
12. The approximate value of PI ($\pi$) is 3.14.
13. Formulas for the circle:

    Diameter = 2 x radius

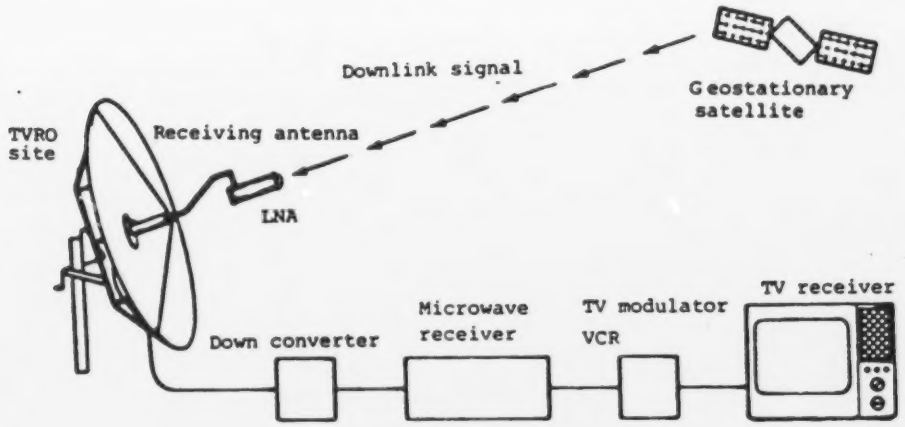
    Circumference = 2 x $\pi$ x radius

    Area = $\pi$ x radius$^2$ = x radius x radius

# Television via Satellite

## Receiving System

THE ANTENNA




MATH CONCEPTS

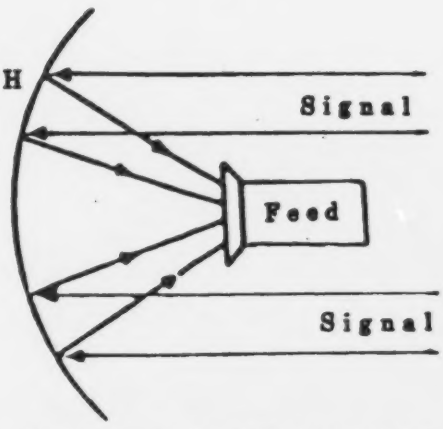
GEOMETRIC SHAPES

PARABOLA

FOCAL LENGTH

CIRCLE

SINE WAVE




SCIENCE CONCEPTS

ELECTROMAGNETIC SPECTRUM

ENERGY CONVERSIONS

GEOSYNCHRONOUS ORBIT

WAVELENGTH

FREQUENCY

TITLE: SPEAKER CONSTRUCTION

CATEGORY: SYSTEM

DESCRIPTION:

A speaker converts the electrical energy from a power amplifier into sound waves. This process is accomplished by passing electrical current through a wire in the presence of a magnetic field. The coil in the magnetic field is connected to the cone in the speaker which produces sound waves. Complex sound waves are produced by applying complex electrical waves to the speaker coil. Speaker enclosures are necessary to prevent low-frequency wave loss from the rear of the speaker.

SCIENCE CONCEPTS:

1. Sound is a wave form of mechanical energy.
2. The speed of sound is 1100 ft. per sec.
3. A wave transfers energy; a wave can perform work.
4. The wavelengths of sound waves vary from 3/4" for very high pitched sounds to 50 ft. for the very lowest audible tones.
5. Frequency is the number of wavelengths passing a point in a second. Frequency is expressed in cycles per second.
6. A speaker will convert electrical energy into sound energy.
7. Sound production in electromagnetic speakers is based on Farraday's Law.
8. Tweeters are speakers designed to reproduce sounds from the high frequency range. Woofers will reproduce sound from the low frequency range.
9. Sound waves require a medium in which to travel.
10. Diffraction is the bending of sound waves while they are traveling in the same medium.
11. The Law of Superposition states that the existence of one wave does not affect the existence of a second wave, even if they are at the same place, at the same time.
12. Speaker enclosures prevent low frequency waves from the rear of the speaker, from diffracting around to the front and interfering, destructively, with the waves from the front.
13. The "infinite baffle" type enclosure allows no mixing of waves from the back to the front of the speaker.

SCIENCE CONCEPTS:

(CONTINUED)

14. The "acoustic suspension" enclosure is an air tight box, in which the speaker is suspended.

15. The "tuned port" enclosure is the most efficient of the electromagnetic speaker systems.

MATHEMATICAL CONCEPTS:

1. Sine waves.

2. Frequency--differentiation between various frequencies for crossovers.

3. Wavelength.

4. Amplitude.

5. Velocity equals wavelength times frequency.

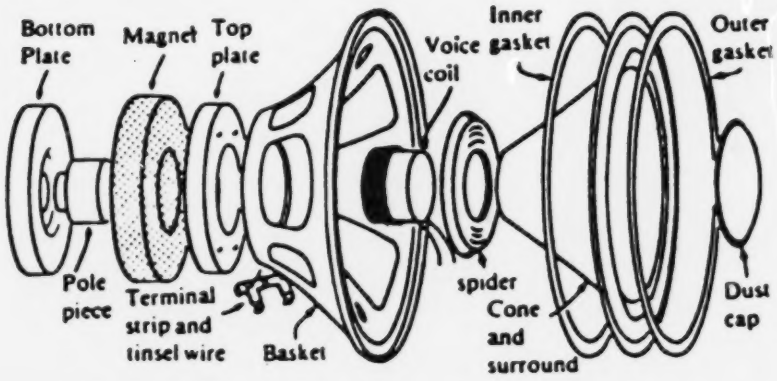
   $V = F \times W$

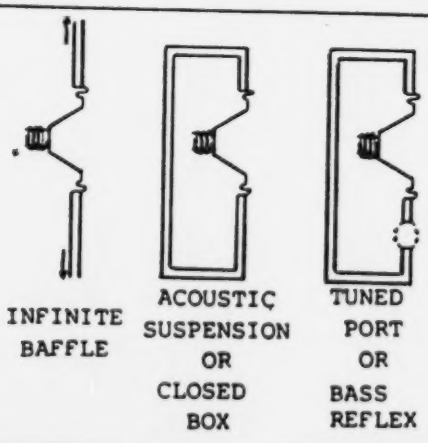
6. Speed of sound is a constant (1100 ft./sec.).

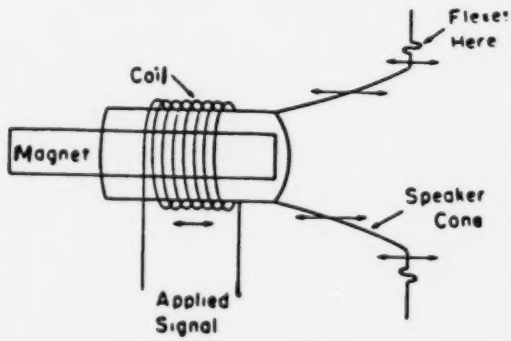
7. Higher frequency means shorter wavelength and vice versa.

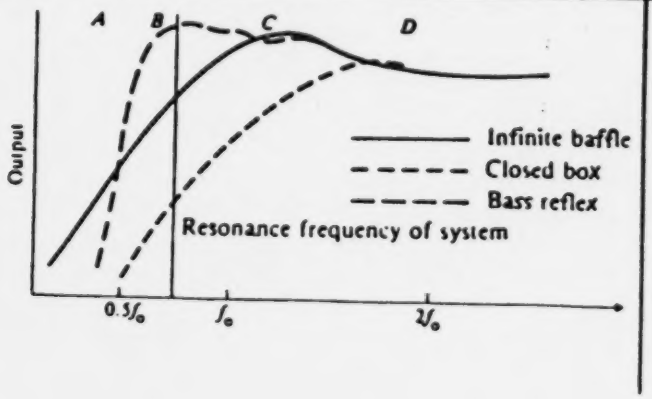
8. Measurement involved in the construction.

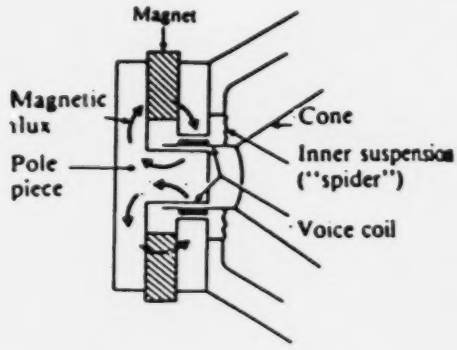
# SPEAKER CONSTRUCTION






BEST COPY AVAILABLE

Title: Sundial

Category: Innovation

Description:

The sundial dates as far back as 1500 BC and was essentially a simple device for measuring solar time. It consisted of a rod, called a gnomon, which was fastened in place on a flat surface, or dial. The dial was marked off to show increments of time. Once the principle was understood, variations of sizes and shapes developed. Large dials were situated in public places. Smaller ones were constructed for private use and even as jewelry. Despite the inherent problems of telling standard time with an instrument designed to measure solar time, the accurately designed sundial is still a reliable instrument for telling time.

Title: Sundial

Category: Innovation

Science Concepts:

Definitions:

1. Axis - Imaginary line running from pole to pole in the earth about which the earth rotates.
2. Latitude - The angular distance a location is north or south of the equator.
3. Rotation - Spinning of an object about an axis.

Principles:

1. The earth rotates on its axis once every 24 hours. This causes any location on the earth to move through a complete circle every 24 hours. Consequently, the sun appears to move across the sky 15 degrees every hour. That means the sundial face must be divided every 15 degrees to represent the hours.
2. The earth rotates from east to west which causes the sun to rise in the east and set in the west. At all latitudes north of the Tropic of Cancer the sun will always be south of the observer. Shadows are created when an object blocks the light from the sun, therefore, an object's shadow will always be on the side opposite the sun. This means the shadow will be west of the gnomon in the morning, east of the gnomon in the evening, and always remain north of the gnomon. The arrangement of hours on the face of the dial will have the morning hours on the west side, the evening hours on the east. All hours should be marked to the north of the gnomon.

Title: Sundial

Category: Innovation

Science Concepts:

Principles:

3. To establish the angle for the gnomon the latitude must be found. The gnomon is constructed parallel to the axis of the earth. When the gnomon is parallel to the axis the sun will appear to revolve around the gnomon on the first day of spring and fall.
4. The sun's apparent position in the sky changes during the year. On the first day of summer it is located directly over the Tropic of Cancer ($23.5^{o}N$) and on the first day of winter it is located directly over the Tropic of Capricorn ($23.5^{o}S$). To an observer at a given latitude north of the Tropic of Cancer the sun's position in the sky changes by 47 degrees between summer and winter. This change in height above the southern horizon causes the angle of the shadow to change by nearly 8 degrees each month. Circles can be placed on the dial to represent the months by finding the length of the shadow for each month.

Title: Sundial

Category: Innovation

Math Concepts:

1. Angle measurement

The gnomon forms an angle with the dial. The measure of this angle must equal the latitude of the location on Earth where the sundial will be used. Our latitude in Maryland is $39^{o}$N. Therefore, we must use the protractor to set the angle of the gnomon at $39^{o}$.

Parallels of latitude are a set of concentric circles measured in degrees. The Equator is zero degrees and the poles are $90^{o}$. Consider a circular cross section of the sphere. The arc from pole to Equator forms a central angle of $90^{o}$. From any point on this arc, we can draw an acute central angle. The parallel of latitude is equal to this central angle measure.

2. Linear measure

Most scientists and mathematicians use the metric system of linear measure. A major advantage of this system is the facility of converting from one unit to another. Conversion is simplified since all subdivisions of metric units are base ten, consequently moving the decimal point will convert to powers of ten. This skill can be employed when gathering data for purposes of graphing.

3. Time measure

Caution must be used by the student when operating (adding and subtracting) with units of time. Seconds and minutes are base 60. Hours are a multiple of 6, but not a power of 6. Days in the week, the month and the year are all different bases. Students who are accustomed to functioning in a decimal system, i.e. base ten, must make the necessary adjustments when calculating time.

Title: Sundial

Category: Innovation

Math Concepts:

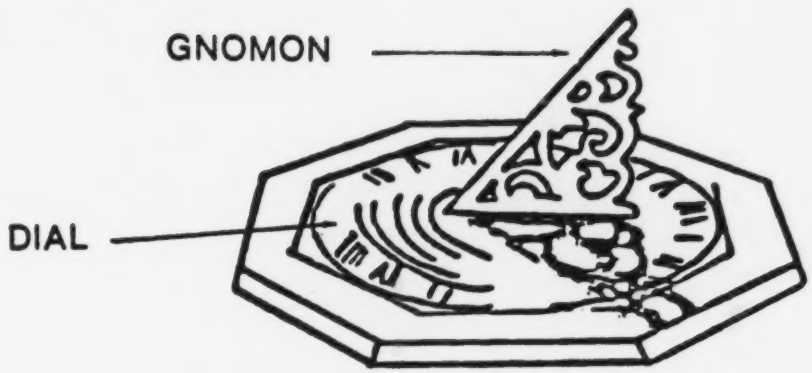
4. Graphing

Linear graphs can serve as a visual means for analyzing observations made by using the sundial. The student could record the length of shadows on an hourly or weekly basis. The vertical axis is the length of the shadows, the horizontal axis the units of time. For each given period of time a shadow length is plotted on the graph. Joining these points with a line should result in a definite pattern of ascent and/or descent. This characteristic of line graphs makes them well suited for making predictions about a set of data.

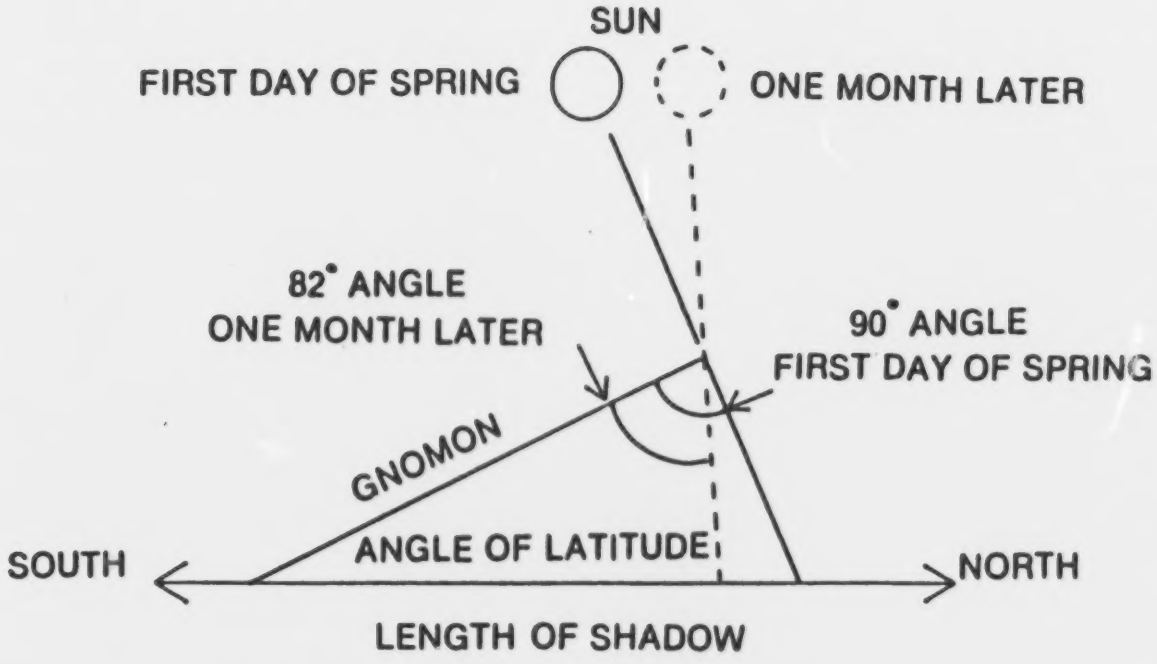
5. Finite Number Systems

Most of the number systems with which we operate are finite, i.e. whole numbers, integers, rationals. The sundial gives us an opportunity to introduce and analyze finite number systems. Consider the set of elements in Clock Arithmetic to be (0, 1, 2, 3, 4, 5, 6, 7, 8, 9, ,0, 11) where 12 is replaced by the identity element 0. Some experimentation will reveal that we can add, subtract, multiply and divide; always getting a solution within the system. Thus, the system has closure. More experimentation will allow the student to analyze this system under each of the 4 operations to determine the existance of other properties.

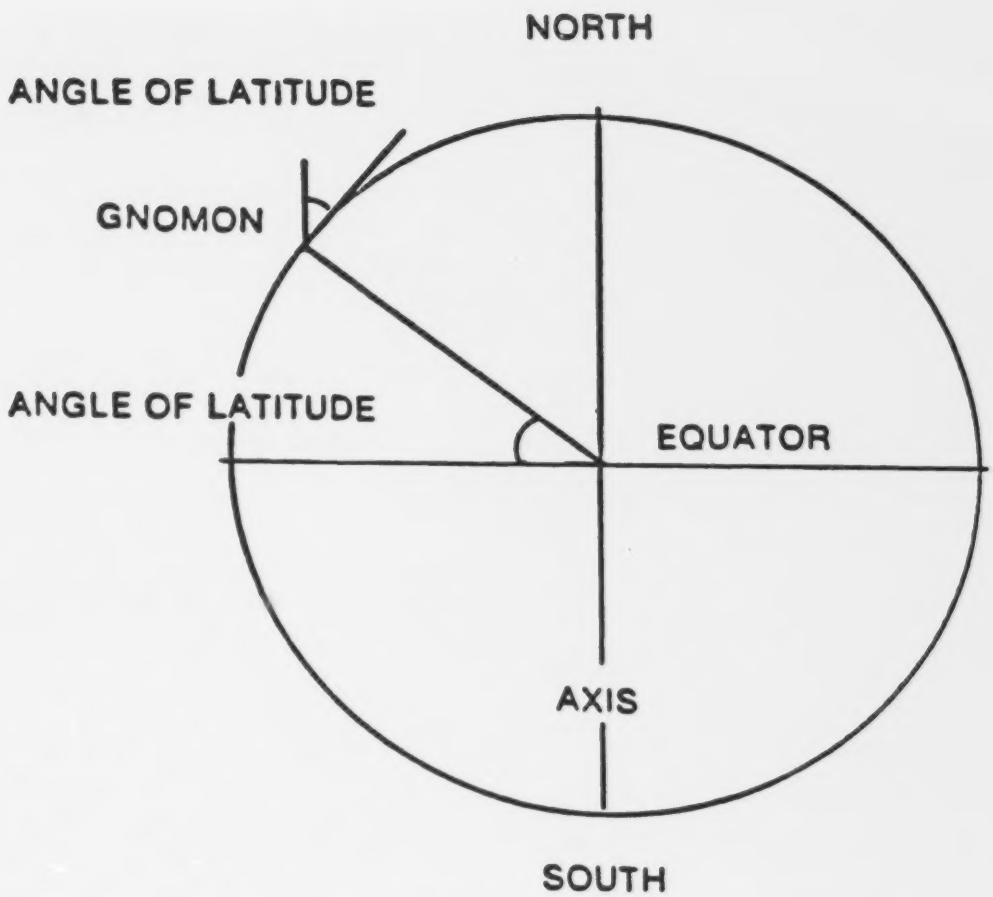
# SUNDIAL



# SUNDIAL


SUN
FIRST DAY OF SPRING
ONE MONTH LATER
82° ANGLE
ONE MONTH LATER
90° ANGLE
FIRST DAY OF SPRING
GNOMON
ANGLE OF LATITUDE
SOUTH
NORTH
LENGTH OF SHADOW

# SUNDIAL




ANGLE OF GNOMON = ANGLE OF LATITUDE

TITLE: TELEGRAPH

CATEGORY: INNOVATION

DESCRIPTION:

With the invention of the electromagnet the field of communication was greatly expanded. Samuel F.B. Morse was credited with the invention of the telegraph in 1837. The principle behind the telegraph was quite simple: Each end of the telegraph circuit contained a switch called a key and an electromagnet-armature-stop combination called a sounder. The circuit used with the telegraph was a series. In the operation of the telegraph both keys were kept closed. When the operator at one end of the line wanted to send a message, he opened his key, thus breaking the circuit. When he closed his key, both sounders operated producing a quick succession of code groups representing the letters of the alphabet.

SCIENCE CONCEPTS:

1. Simple machines--devices that help you do work by increasing force, increasing speed, or changing the direction of the force.

   Lever and fulcrum--a bar or board that is free to pivot about a fixed point called the fulcrum.

2. Energy is defined as the ability to do work.

3. Energy conversions occurs as energy is being transferred from mechanical to electrical to mechanical.

4. A magnetic field is said to exist in a region where magnetic forces can act.

5. Electromagnetic induction is the production of an electric current by a changing magnetic field.

6. The lines of force in a magnetic field comprise the flux. The flux is created by the action of the magnetomotive force, and both bear a relationship to the reluctance of the substance being magnetized.

TITLE: TELEGRAPH

CATEGORY: INNOVATION

MATHEMATICAL CONCEPTS:

1. Simple Formulas

   Ohm's Law $I = \frac{E}{R}$ , $E = I \times R$

   Current (Amps) = $\frac{\text{Electromotive Force (volts)}}{\text{Resistance (Ohms)}}$

   Flux = $\frac{\text{Magnetomotive Force (M.M.F.)}}{\text{Reluctance (Magnetic Resistance)}}$

2. Mathematical operations

3. Use of rational numbers

4. Order of operations

5. Solving equations with variables

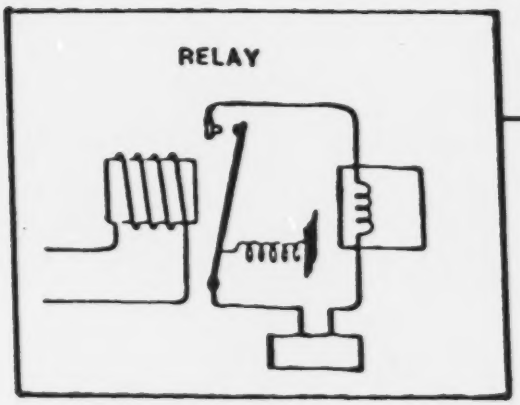
# TELEGRAPH

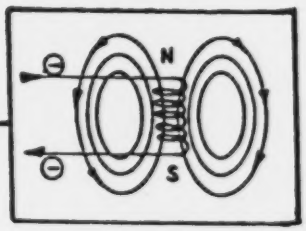
... CONVERSION OF ENERGY ▷ MECHANICAL TO ELECTRICAL

## TRANSMIT

ELECTROMAGNETIC INDUCTION:

$$V = N \times \frac{\text{CHANGE IN FLUX}}{\text{CHANGE IN TIME}}$$



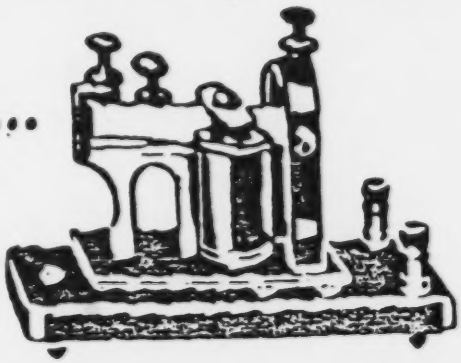




OHM'S LAW

$$I = \frac{E}{R}$$

## RECEIVE

CONVERSION OF ENERGY ▷ ELECTRICAL TO MECHANICAL ...



BEST COPY AVAILABLE

**TITLE:** Telephone

**DESCRIPTION:**

The telephone is an electro-mechanical device. It converts air vibrations (sound) into mechanical electrical impluses which are then carried by conductors to a device which converts the electrical impluses back into mechanical vibrations which result in a vibration of the air (sound).

SCIENCE CONCEPTS:

1. The telephone transmitter receives the sound waves and sends the effect of the waves to the receiver by electricity.

2. Carbon is a semi-conductor of electricity. In the transmitter, there is a small round box in which carbon granules are placed. One side of the box is fastened to a diaphragm, or metal disk. When sound waves hit the disk the disk vibrates. The movement of the disk moves the cover of the box and presses on the carbon particles. An electric current (D.C.) flows to the box cover, through the carbon, and out of the box, to vary the pressure of current passing through.

3. The job of the receiver is to change current flow back to sound waves.

4. In the telephone receiver a disk or diaphragm is made to vibrate and make sound waves so that the ear may hear. An electromagnet is connected to the circuit from the transmitter. The force of the current traveling through the electromagnet varies with the differnet sound waves hitting the transmitter diaphragm. The change in strength of the magnetism in the magnet and attracts the receiver diaphragm with varied "pulls." The diaphragm in the receiver is made to vibrate exactly as the sound waves make the diaphragm in the transmitter vibrate. (The core of the magnet is a permanent magnet to hold the diaphragm in place.)

5. Parts of the telephone are:

   A. Sound waves
   B. Electrical waves
   C. Transmitter
   D. Receiver
   E. Transmissive Network

**TITLE:** Telephone

**DESCRIPTION:**

The telephone is an electro-mechanical device. It converts air vibrations (sound) into mechanical electrical impluses which are then carried by conductors to a device which converts the electrical impluses back into mechanical vibrations which result in a vibration of the air (sound).

**MATH CONCEPTS:**

1. Ohm's Law for finding current

$$I = \frac{E}{R}$$

Which states current (I) equals voltage (E) divided by resistance (R) is the equation used to calculate current used by a telephone.

2. The resistance formula states that resistance (R) equals voltage (E) divided by current (I).

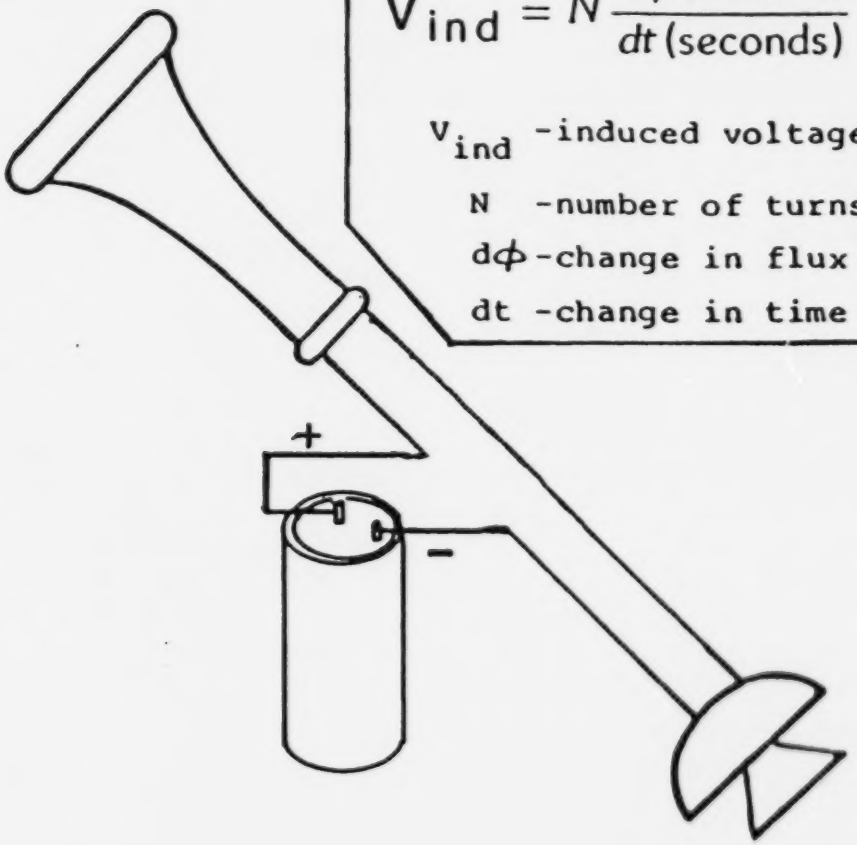
$$R = \frac{E}{I}$$

3. Ohm's Law for finding voltage is:

$$E = I \times R$$

This formula states that voltage (E) equals current (I) times resistance(R).

# TELEPHONE OPERATION




**FARADAY'S LAW**

$$V_{ind} = N \frac{d\phi\,(\text{webers})}{dt\,(\text{seconds})}$$

$V_{ind}$ -induced voltage

N -number of turns

$d\phi$ -change in flux

dt -change in time

**TRANSMITTER**

VIBRATING AIR MOLECULES

↓

△ PRESSURE IN STEEL DIAPHRAGM

↓

△ PRESSURE IN CARBON GRAINS

↓

△ DENSITY OF CARBON

↓

△ RESISTANCE OF CARBON

↓

△ CURRENT FLOW

TITLE: TELESCOPE

CATEGORY: INNOVATION

DESCRIPTION:

By 1609 telescopes could be bought on the open market, and the following year Galileo turned one toward the sky and began a revolution in astronomy. Modern applications of telescopes include gunsights and other military purposes, use in surveying instruments and laboratory spectroscopes, as well as their obvious role in astronomical research.

SCIENCE CONCEPTS:

1. Light is a form of energy that travels in straight lines called rays, except when it is refracted.
2. Light can be reflected or refracted.
3. Refraction is the bending of light rays.
4. The Law of Refraction applies when a transparent material bends or changes the direction of the light ray.
5. Lenses are used to refract light.
6. A lens is a curved, transparent substance, such as glass, which diverges or converges beams of light.
7. There are two types of lenses, the convex and concave.
8. A convex lens is curved outward and converges light rays.
9. A concave lens is curved inward and diverges light rays.
10. Telescopes utilize both convex and concave lenses or mirrors.
11. A telescope is an instrument used to make faraway objects appear closer.
12. There are two basic types of telescopes, the refracting and reflecting telescope.
13. The refracting telescope utilizes a convex lens.
14. A convex lens is thicker at the center.
15. As light strikes one edge of the lens, it is bent as it passes through the lens and is refracted toward the base.
16. The rays at the thinnest part of the lens move faster and are refracted more than the portion of the light rays moving through the center part of the lens.
17. The rays converge toward a single focal point.

SCIENCE CONCEPTS:

(CONTINUED)

18. The focal point is the place where light rays from a lens meet.

19. The image is smaller than the object, past the focal point and is upside down.

20. The rays then seem to spread away from the focal point causing the object to be magnified.

21. The convex lens makes an image of the distant object.

22. The image it makes is called a real image.

23. A real image can be projected on a screen.

24. In the refracting telescope, the convex lens is in the front and is called the objective.

25. The light reflected from a distant object passes through this lens and is focused inside the tube of the telescope.

26. Reflected light is light that has bounced off something.

27. The eyepiece lens (another convex lens) is at the back of the telescope.

28. The eyepiece lens magnifies the inverted image many times its true size.

TITLE: TELESCOPE

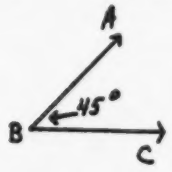
CATEGORY: INNOVATION

MATHEMATICAL CONCEPTS:

1. An angle is an open figure formed by the intersection of two straight lines that open as they extend from a common starting point called a vertex.

2. An angle is measured in terms of degrees (°), minutes (m), and seconds (s).

3. An angle may be denoted by $\angle ABC$, $\angle B$, $\angle \theta$, or $\angle 2$.




4. The magnification of the lens can be determined if the distances from lens to object ($D_i$) and lens to image ($D_o$) are known.

   Magnification Formula: $\text{Magnification} = \frac{\text{Image Height}}{\text{Object Height}}$

   $$m = \frac{D_i}{D_o}$$

5. The lens formula is used to give positive answers if the image is real and therefore on the opposite side of the lens from the object.

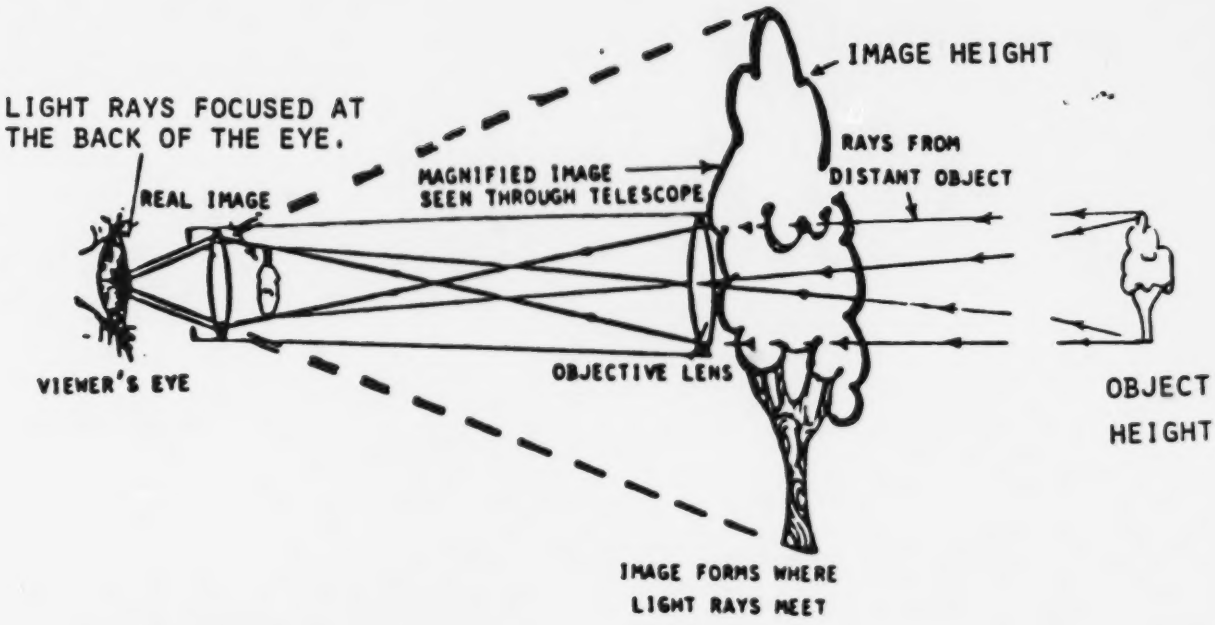
   Lens Formula: $\frac{1}{f} = \frac{1}{D_o} + \frac{1}{D_i}$

6. The f-number compares the diameter of a lens to its focal length.

   For example, if the focal length (f) of a lens is six times its diameter ($f = 6 \times D$), the lens is marked as "f/6":

7. The f-number formula is $\frac{f}{f\ (\text{number})} = \text{Diameter}$

# TELESCOPE




AT THE FRONT OF THE SIMPLE REFRACTING TELESCOPE IS A LARGE CONVEX LENS CALLED THE OBJECTIVE.

LIGHT REFLECTED FROM A DISTANT OBJECT PASSES THROUGH THIS LENS AND IS FOCUSED INSIDE THE TUBE OF THE TELESCOPE.

THE EYEPIECE LENS AT THE BACK MAGNIFIES THIS INVERTED IMAGE MANY TIMES ITS TRUE SIZE.

$$\text{MAGNIFICATION} = \frac{\text{IMAGE HEIGHT}}{\text{OBJECT HEIGHT}}$$

TITLE: TELEVISION CAMERAS

CATEGORY: TOOL

DESCRIPTION:

The television camera consists of three main parts: (1) the lens, which selects a certain field of view and produces a small optical image of this view; (2) the camera itself with its camera pickup tubes, which converts the optical image into electrical signals; and (3) the view finder, which converts these electronic signals back into a visible screen image.

SCIENCE CONCEPTS:

1. A foot-candle (fc) equals 1 lumen per square foot. A unit of luminance.
2. The science of measuring light is called photometry.
3. The luminous intensity is measured in candle intensity per square foot.
4. A relationship exists with any mirror between the distance of an object, the distance of its image and the focal length of a curved mirror.
5. A lens is a portion of a transparent substance bounded by at least one nonparallel surface.
6. Focal length is the distance between the principal focus of a lens or mirror and its optical center.
7. The f-stop is the ratio of the focal length of a lens to the effective aperture.
8. A prism is a transparent solid cut at precise angles for various optical purposes.
9. Reflected light is light that is bounced off the illuminated object.
10. Current is the rate of flow of electrons. The resistance of a conductor is measured in Ohms.
11. The electrical pressure which causes the flow of current is measured in volts. A unit of power is called a watt.

TITLE: TELEVISION CAMERAS

CATEGORY: TOOL

MATHEMATICAL CONCEPTS:

1. $E=\frac{F}{A}$ F=luminous flux in lumens (lux)
   A=area in m or ft
   E=illumination in lumens per square units

2. $\text{f-stop}=\frac{\text{focal length of a lens}}{\text{effective aperture}}$

3. wattage=volts x amps where watt measures power

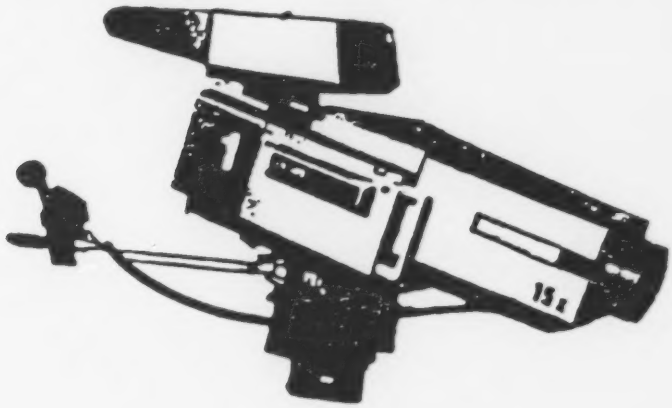
4. $\frac{1}{f}=\frac{1}{D_o}+\frac{1}{D_i}$ Focal length of mirrors and lenses
   f=focal length
   D =object distance
   D =image distance

5. $\frac{S_i}{S}=\frac{D}{D}$ Images in mirrors and lenses
   S =object size
   S =image size
   D =object distance
   D =image distance

6. $n=\frac{\sin i}{\sin r}$ Index of refraction
   n=index of refraction
   i=angle of incidence
   r=angle of refraction

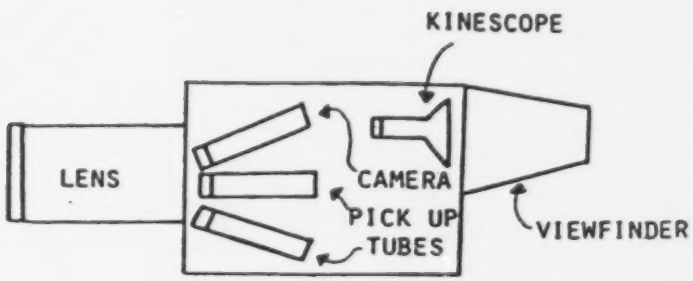
7. $M=\frac{25\text{ cm}}{f}$ Simple magnifier
   f=focal length of lens

# TELEVISION CAMERA



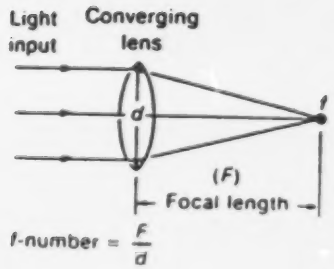
MATH CONCEPTS:

- LUX
- F-STOP
- E = I x R
- FOCAL LENGTH
- REFRACTION
- MAGNIFICATION




SCIENCE CONCEPTS:

- LIGHT
- OPTICS
- ELECTRICAL PRESSURE
- APERTURE
- LENSES & MIRRORS






BEST COPY AVAILABLE